MINE PLAN OF OPERATIONS

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Twin Metals Minnesota LLC

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Twin Metals Minnesota Project: An Introduction

Twin Metals Minnesota (TMM) is proud to formally propose its world-class, 21st century underground copper, nickel, cobalt and platinum group metals mining project in northeast Minnesota for environmental review.

The submission of TMM's Mine Plan of Operations (MPO) to the U.S. Bureau of Land Management (BLM), and the Scoping Environmental Assessment Worksheet (SEAW) data submittal to the Minnesota Department of Natural Resources (MDNR), is the culmination of a decade of engineering, environmental and engagement work including the evaluation of dozens of Project configurations and technologies that maximize environmental protection. If permitted, TMM's Project will be the state's first underground mining operation – an approach that minimizes surface disruption, noise and dust -- since the closure of Ely's Pioneer Mine in 1967.

For more than 135 years, Minnesota has been a leader in both mining development and regulation to ensure strong environmental and labor standards. TMM is dedicated to building, operating, and closing a mine that employs industry best practices and meets or exceeds all state and federal environmental standards.

Submission of the MPO and SEAW starts a multi-year environmental review process that will thoroughly evaluate this proposal. The review process will include additional baseline data collection, impact analysis, and multiple opportunities for public input. TMM looks forward to this process and the engagement with government and the public which will result in the best outcomes for Minnesota.

The TMM Project site is located between the cities of Ely and Babbitt, an area long-sustained by mining and other industries, including farming, logging, quarries, and recreation. The area in and around Ely alone was once home to 11 operating mines. The site is in an area of the Superior National Forest designated for mining and logging within the U.S. Forest Service Superior National Forest Plan. The Project is outside of the Boundary Waters Canoe Area Wilderness and both the federal and state mining exclusion zones meant to provide a buffer from development.

The TMM Project offers an extraordinary opportunity for long-term, environmentally sound economic growth and job creation in a region of northeastern Minnesota that never fully recovered from iron mine and processing plant closures a generation ago. The construction phase of the project will require several million labor hours under a project labor agreement already negotiated with the Iron Range Building and Construction Trades Council. Once the mine is operational, it will bring 700 new full-time, skilled positions and 1,400 spinoff jobs to the region. Investment in the Project to date is over $450 million and is expected to amount to approximately $1.7 billion through construction of the mine. The Project would provide additional economic benefit by generating revenue for state and federal governments from taxes and mineral royalties.

The growing demand for copper, nickel, cobalt and platinum group metals in technologies from cell phones to clean energy production has made these minerals critical to advancing the quality of life of populations around the globe. The Duluth Mineral Complex beneath this part of northeastern Minnesota is one of the largest
undeveloped deposits of these minerals in the world, with more than 7 billion tons of ore containing copper, nickel and other precious metals. Failure to access the minerals of the Duluth Complex will create pressures to mine these metals in other locations that have much less rigorous environmental and labor standards.

TMM and its predecessor company engaged in mineral resource characterization of the Maturi deposit, in the northern area of the Duluth Complex, from 2006 to 2014. This effort has produced detailed characterization of mineral resources. To date, TMM's core storage facility houses approximately 1.5 million feet of core samples from the Maturi deposit; about a half million additional feet of core samples have been sent to state storage facilities. Following mineral resource characterization, several years of process flowsheet engineering work led to conceptual and initial prefeasibility studies.

The outcome of these studies minimized potential impacts in the areas of water, wetlands, noise, dust, light and visual pollution. Specific examples include:

- Project optimization reduced the surface footprint by over four times;
- Ore processing would remove most of the sulfide minerals; therefore, tailings would not produce acid rock drainage (ARD);
- Up to 50% of tailings would be diverted from surface storage and instead be utilized as backfill in the underground mine;
- Tailings stored on surface would be dewatered and compressed which is called dry stacking;
- Adopting dry stacking as the tailings management method reduced the surface impact by approximately 35% and wetlands impact by approximately 65% compared to a previous conventional slurry tailings storage configuration;
- The dry stack facility would not have dams retaining tailings slurry, would be lined and covered, would eliminate a long pipeline to transport tailings to another location, and would be revegetated concurrently as the Project progresses reducing visual impacts;
- The Project would not discharge process water and is designed not to require discharge of contact water. Water used in the mineral concentration process would be reused on site;
- No waste rock would be stored on the surface, eliminating a potential source of ARD;
- Ore crushing would be underground, limiting surface impact, dust and noise;

- No mining would occur under Birch Lake reservoir; and
- After mine closure, most of mine infrastructure would be removed and the surface area revegetated.

Project at a glance:

- Construction of the mine would occur over two to three years;
- The mine would process 20,000 tons of ore per day;
- Mining operations would occur between 400 and 4,500 feet below the surface;
- The tailings management site would be approximately one mile south of the underground mine and encompass the dry stack tailings facility;
- The plant site includes access to the underground mine and the concentrator used to recover target minerals from ore;
- The mine would be accessed via declines at the plant site with workers and supplies transported by truck;
- Flow of groundwater in bedrock is exceptionally low;
- Water for operations would be reused on site and be sourced from stormwater, groundwater inflow into the mine, and from Birch Lake reservoir;
- Power would be supplied via a transmission corridor from an off-site electrical substation;
- Site employees would be bused to site from Ely and Babbitt, minimizing traffic;
- The Project would operate under National Mining Association CORESafety Program standards, a systematic approach to developing a safety culture.

As the World Bank noted earlier this year in its Climate Change report, the world is rapidly transitioning to low-carbon technologies to combat climate change and will require large quantities of minerals to succeed. The report notes that a single three-megawatt wind turbine requires 4.7 tons of copper. Lithium-ion batteries used in everything from electric vehicles to power grids rely heavily on cobalt, one of the key minerals identified in the Maturi deposit. Catalytic converters, which reduce carbon monoxide emissions from internal combustion engines, use another: platinum group metals such as palladium. Nickel is a key component of corrosion-resistant alloys such as stainless steel and copper-nickel tubing in desalinization plants. The report projects that the transition to green energy will require as much copper in the next 25 years as has been produced in the past 5,000 years.

This Project offers the opportunity to provide the minerals essential to the green economy responsibly, with the rigorous environmental and labor standards that are uniquely present here in America – specifically in Minnesota. TMM's commitment is to operate sustainably and preserve and protect our precious natural world as we support the new, green economy.

Closer to home, hundreds of union jobs, over a thousand spinoff jobs, as well as tax payments and royalties will improve the quality of life in Minnesota and specifically in communities that are struggling economically. TMM's Project raises the bar for how to best extract necessary minerals for society. With this Project, Minnesota can be a model for modern, sustainable and environmentally and socially responsible mining.

TABLE OF CONTENTS

1.0 OPERATOR INFORMATION 1
1.1 OPERATOR INFORMATION 1
1.2 COMPANY INFORMATION 1
1.2.1 Chief Executive Officer 1
1.2.2 Chief Regulatory Officer 1
1.3 ORGANIZATIONAL STRUCTURE 2
2.0 DESCRIPTION OF OPERATIONS 2
2.1 BACKGROUND AND HISTORY 3
2.2 SITE ACCESS 4
2.2.1 Underground Mine 4
2.2.2 Plant Site 4
2.2.3 Tailings Management Site 4
2.2.4 Non-Contact Water Diversion Area 5
2.2.5 Water Intake Corridor 5
2.2.6 Transmission Corridor 5
2.3 UNDERGROUND MINE 5
2.3.1 Portals and Declines 6
2.3.2 Blasting 6
2.3.3 Crushing and Underground Ore Handling System 7
2.3.4 Backfill 7
2.3.5 Mine Dewatering System 8
2.3.6 Mine Ventilation System 9
2.3.7 Underground Facilities 10
2.4 PLANT SITE 12
2.4.1 Ore Storage Facilities 13
2.4.2 Surface Conveyors 14
2.4.3 Concentrator Building 15
2.4.4 Comminution Circuit 15
2.4.5 Flotation Circuit 16

2.4.6 Concentrate Dewatering and Storage 18
2.4.7 Plant Site Surface Infrastructure and Ancillary Facilities 19
2.5 TAILINGS MANAGEMENT SITE 25
2.5.1 Tailings Thickener 25
2.5.2 Filter Plant 25
2.5.3 Filter Cake Storage and Loadout Building 26
2.5.4 Backfill Plant 26
2.5.5 Dry Stack Facility 26
2.5.6 Wash / Spray Station 28
2.5.7 Monitoring 28
2.5.8 Reclamation Material Stockpile 28
2.5.9 Power Distribution 28
2.6 NON-CONTACT WATER DIVERSION AREA 29
2.7 ACCESS ROAD 29
2.8 WATER INTAKE CORRIDOR 29
2.9 TRANSMISSION CORRIDOR 30
2.10 PRODUCTION SCHEDULE 30
2.11 STAFFING 30
2.12 ROCK MANAGEMENT 31
2.13 WATER SUPPLY AND MANAGEMENT 32
2.13.1 Mine Supply Water Storage 34
2.13.2 Contact Water Ponds 34
2.13.3 Process Water Storage 35
2.13.4 Process Water 36
2.13.5 Surface Water Management 37
2.14 TRANSPORTATION AND CONVEYANCE 39
2.15 WASTE MANAGEMENT 39
2.15.1 Solid Waste 39
2.15.2 Sanitary Waste Handling 40
2.15.3 Hazardous Waste 40

2.16 CONSTRUCTION PHASE 40
2.16.1 Construction Schedule 40
2.16.2 Construction Access 40
2.16.3 Clearing and Grubbing 41
2.16.4 Dry Stack Facility 41
2.16.5 Transmission Corridor 41
2.16.6 Water Intake Corridor 42
2.16.7 Plant Site Surface Infrastructure 42
2.16.8 Portal and Mine Decline Development 43
2.16.9 Underground Mine Development 43
2.16.10 Ore Stockpiling - Temporary Rock Storage Facility 43
2.16.11 Development Rock and Construction Materials 43
2.16.12 Concentrator and Tailings Dewatering Plant 44
2.16.13 Equipment 44
2.16.14 Electrical Equipment and Materials 44
2.16.15 Construction Stormwater Management 44
2.16.16 Construction Labor 45
2.16.17 Temporary Housing Needs 45
2.17 SITE OPERATIONS SECURITY AND SAFETY 45
2.17.1 Security 45
2.17.2 Employee Health and Safety 45
2.17.3 Safety Evaluation 46
2.17.4 Fire and Emergency Planning 47
2.18 EXPLORATION 48
2.19 OFF-SITE ANCILLARY FACILITIES 48
2.19.1 Administrative Buildings in Ely and Babbitt 48
3.0 ENVIRONMENTAL SETTING 48
3.1 LAND USE AND ZONING 48
3.1.1 Existing Land Use 48
3.1.2 Planned Land Use 50

3.1.3 Current Zoning and Management Codes 52
3.2 GEOLOGY, SOILS, AND TOPOGRAPHY / LAND FORMS 54
3.2.1 Bedrock 54
3.2.2 Surficial Geology 55
3.2.3 Mineralogy 55
3.2.4 Structure 56
3.2.5 Soils and Topography / Landforms 56
3.3 PALEONTOLOGICAL RESOURCES 57
3.4 WATER RESOURCES 58
3.4.1 Surface Water 58
3.4.2 Groundwater 61
3.4.3 Wetlands 63
3.5 HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTE 65
3.6 TERRESTRIAL AND AQUATIC RESOURCES 65
3.6.1 Terrestrial Resources 65
3.6.2 Aquatic Resources 68
3.7 HISTORIC PROPERTIES AND CULTURAL RESOURCES 70
3.7.1 Archaeological Sites 71
3.7.2 Historic Properties 71
3.7.3 Cultural Resources 72
3.8 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE OF THE LOCAL COMMUNITY 73
3.9 VISUAL RESOURCES 74
3.10 CLIMATE 74
3.11 AIR 75
3.11.1 Air Quality 75
3.11.2 Air Quality Standards 75
3.11.3 Ambient Air Quality Attainment Status 76
3.12 NOISE 76
3.12.1 Baseline Ambient Noise 76

3.12.2 Nearby Sensitive Receptors 77
3.12.3 State Noise Standards 77
3.13 TRANSPORTATION 78
3.13.1 Traffic Conditions 78
3.13.2 Traffic Forecast 78
3.13.3 Regional Transportation System 79
4.0 ENVIRONMENTAL PROTECTION MEASURES 79
4.1 GENERAL CONSIDERATIONS, COMMITMENTS, AND DESIGN CRITERIA 79
4.2 WATER RESOURCES 82
4.2.1 General Water Management 82
4.2.2 Facility-Specific Water Management 83
4.3 AIR QUALITY 84
4.4 VISUAL RESOURCES AND LIGHTING 85
4.5 PUBLIC ACCESS AND RECREATION 85
4.6 CULTURAL AND ARCHAEOLOGICAL RESOURCES 86
4.7 BIOLOGICAL RESOURCES 87
4.7.1 Threatened and Endangered and Special Status Species 88
4.7.2 Wetlands 88
4.8 SUBSIDENCE 88
4.9 NOISE 89
4.10 EROSION AND SEDIMENT CONTROL 90
4.11 MATERIALS AND WASTE MANAGEMENT 91
4.11.1 Sanitary and Solid Waste Disposal 91
4.11.2 Hazardous Materials Management 91
4.11.3 Petroleum Contaminated Soils 92
4.12 PROTECTION OF SURVEY MONUMENTS 93
4.13 FIRE MANAGEMENT AND PROTECTION PROCEDURES 93
4.14 NOXIOUS WEEDS AND INVASIVE EXOTIC SPECIES 94
5.0 OPERATING PLANS 94
5.1 NON-CONTACT WATER MANAGEMENT PLAN 94

5.2 CONTACT AND PROCESS WATER MANAGEMENT PLAN 94
5.3 ROCK CHARACTERIZATION AND HANDLING PLAN 95
5.4 ENVIRONMENTAL QUALITY ASSURANCE PLAN 97
5.5 SPILL CONTINGENCY PLAN 97
5.6 INTERIM MANAGEMENT PLAN 97
6.0 REFERENCES 98

TABLES

Located in Tables section at end of document:

Table 2-1: Project Magnitude Surface Disturbance
Table 2-2: Requirements for Leasable Minerals as per 43 Code of Federal Regulations § 3592
Table 2-3: Approximate Emulsion Quantities
Table 2-4: Primary Mining Equipment
Table 2-5: Pre-operational Ore Stockpile Design Parameters and Dimensions Summary
Table 2-6: Primary Fuels
Table 2-7: Primary Reagents
Table 2-8: Plant Site Reclamation Material Stockpiles Design Parameters and Dimensions Summary
Table 2-9: Surface Mobile Equipment
Table 2-10: Tailings Management Site Reclamation Material Stockpile Design Parameters and Dimensions Summary
Table 2-11: Mine Plan Summary Based on Production
Table 2-12: Mine Plan Summary Based on Resource Category
Table 2-13: Labor Profile
Table 2-14: Contact Water Pond Dimensions
Table 3-1: Natural Resources Conservation Service Map Unit Descriptions
Table 3-2: Ecological Land Type Map Unit Descriptions
Table 3-3: Project Component Watersheds
Table 3-4: Public Water Basins within 1 Mile of the Project Area
Table 3-5: Public Watercourses within 1 Mile of the Project Area
Table 3-6: Minnesota National Wetland Inventory Simplified Plant Community Classification Baseline
Table 3-7: Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Baseline
Table 3-8: U.S. Geological Survey GAP / LANDFIRE Data Baseline
Table 3-9: National Land Cover Data Baseline
Table 3-10: Minnesota Department of Natural Resources Minnesota Biological Survey Data Baseline
Table 3-11: Terrestrial Vegetative Sensitive Species
Table 3-12: Terrestrial Wildlife Sensitive Species
Table 3-13: Aquatic Sensitive Species

Table 3-14: Previous Intensive Archaeological Surveys within the Project Area
Table 3-15: Background Criteria Pollutant Concentrations
Table 3-16: Baseline Ambient Noise Levels
Table 3-17: Existing and Forecast Annual Average Daily Traffic with and without Project Trips

FIGURES

Located in Figures section at end of document:

Figure 1-1: Organizational Structure
Figure 2-1: Project Location
Figure 2-2: General Project Layout
Figure 2-3: Simplified Project Schematic
Figure 2-4: Access Road Typical Sections
Figure 2-5: Plant Site Layout
Figure 2-6: Single Lane Road Typical Section
Figure 2-7: Tailings Management Site Layout
Figure 2-8: Water intake Facility and Access road Plan and General Arrangement
Figure 2-9: Transmission Corridor Typical Section
Figure 2-10: Mining Method Schematic
Figure 2-11: Ventilation Raise Layouts
Figure 2-12: Overall Process Flow Diagram
Figure 2-13: Temporary Rock Storage Facility Sections
Figure 2-14: Typical Cross Section of Dry Stack Facility Exterior Slope
Figure 2-15: Dry Stack Facility Typical Ditch Section
Figure 2-16: Water Intake Facility and Access Road Plan and General Arrangement
Figure 2-17: Water Intake Facility Profile
Figure 2-18: Mine Plan by Lease Owner Type
Figure 2-19: Underground Mine Stages – Plan View
Figure 2-20: Underground Mine Stages – Front View
Figure 2-21: Underground Mine Stages – Isometric View
Figure 2-22: Mine Production by Zone over Time
Figure 2-23: Typical Ponds Sections
Figure 2-24: Project Construction Schedule
Figure 2-25: Tailings Management Site Construction Phase
Figure 2-26: Dry Stack Facility Construction Stages
Figure 2-27: Plant Site Construction Phase
Figure 3-1: BWCAW Mineral Management Corridors and MDNR State Forest Management Units
Figure 3-2: 1854 Treaty Ceded Territory
Figure 3-3: Zoning and Land Use Map
Figure 3-4: Private Lands Zoning
Figure 3-5: Federal Land Use
Figure 3-6: Geology of the Duluth Complex
Figure 3-7: Maturi Deposit Stratigraphy

Figure 3-8: Regional Bedrock Geology
Figure 3-9: Bedrock Cross Section A-A' Underground Mine
Figure 3-10: Bedrock Cross Section B-B' Underground Mine
Figure 3-11: Bedrock Cross Section C-C' Underground Mine
Figure 3-12: Bedrock Cross Section D-D' Underground Mine
Figure 3-13: Project Area Topography
Figure 3-14: U.S. Department of Agriculture NRCS Soils Data
Figure 3-15: U.S. Forest Service ELT Soils Data
Figure 3-16: U.S. Geological Survey Hydrological Unit Code Watersheds
Figure 3-17: Minnesota Department of Natural Resources Watersheds
Figure 3-18: Conceptual Hydrologic Model - HGUS
Figure 3-19: Wellhead Protection Area
Figure 3-20: Minnesota Well Index Map
Figure 3-21: National Wetland Inventory Simplified Plant Community Classification
Figure 3-22: National Wetland Inventory Circular 39 Classification
Figure 3-23: Ecological Classification System Subsections
Figure 3-24: U.S. Geological Survey National Gap Analysis Program Project Land Cover
Figure 3-25: U.S. Geological Survey National Land Cover Database – Land Cover
Figure 3-26: Minnesota Biological Survey Data
Figure 3-27: Vegetative and Terrestrial Wildlife NHIS Data
Figure 3-28: Wind Rose
Figure 3-29: U.S. Forest Service Ambient Noise Measurement Locations
Figure 3-30: Sensitive Receptors - Noise
Figure 3-31: Key Transportation Corridors

APPENDICES

Appendix A: Mineral and Surface Ownership Information
Appendix B: Reclamation Plan
Appendix C: Non-Contact Water Management Plan
Appendix D: Contact and Process Water Management Plan
Appendix E: Transportation Plan
Appendix F: Spill Contingency Plan
Appendix G: Environmental Quality Assurance Plan
Appendix H: Interim Management Plan

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

<	less than
>	greater than
°	degree
%	percent
§	section

AADT	annual average daily traffic
amsl	above mean sea level
AO	Authorized Officer
ARD	acid rock drainage
ARDC	Arrowhead Regional Development Commission
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
BMZ	basal mineralized zone
BWCAW	Boundary Waters Canoe Area Wilderness
C	Celcius
CAA	Clean air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
cm/sec	centimeters per second
CO	carbon monoxide
CWA	Clean Water Act
dBA	decibels as measured on the A-weighted scale
DOT	Department of Transportation
EDMS	Environmental Data Management System
e.g.	Latin phrase exempli gratia meaning “for example”
EJ	Environmental Justice
ELT	Ecological Land Type
F	Fahrenheit
ft	foot
gal	gallon
gal/hr	gallon per hour
GAP	Gap Analysis Program
gpm	gallons per minute
GRB	Giants Range Batholith
H:V	horizontal to vertical
ha	hectare
HDPE	high density polyethylene
HHS	U.S. Department of Health & Human Services
HU	Hydrogeologic Unit
HUC	Hydrologic Unit Code
HWY	highway
IBI	Biotic Integrity

i.e.	Latin phrase *id est* meaning “That is (to say)…”
INCO	International Nickel Company, Ltd
km	kilometers
L	liter
LHD	load-haul-dump
LLDPE	linear low-density polyethylene
LLR	longitudinal longhole retreat
LMF	Laurentian Mixed Forest
LOS	level of service
m	meter
m^3	cubic meter
m^3/hr	cubic meter per hour
MBTA	Migratory Bird Treaty Act
MDA	Minnesota Department of Agriculture
MDNR	Minnesota Department of Natural Resources
meq/L	Milliequivalent per liter
MnDOT	Minnesota Department of Transportation
mm	millimeter
MPCA	Minnesota Pollution Control Agency
MPO	Mine Plan of Operations
Mst	Million short tons
MSHA	Mine Safety and Health Administration
Mt	Million tonnes
MWI	Minnesota Well Index
NAAQS	National Ambient Air Quality Standards
NAC	noise area classifications
NFR	National Forest Road
NHIS	Natural Heritage Information System
NLCD	National Land Cover Database
NO_2	nitrogen dioxide
NPC	Native Plant Community
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSU	Northern Superior Uplands
NWI	National Wetland Inventory
OHV	off-highway vehicle
OSA	Office of the State Archaeologist
OSHA	Occupational Safety and Health Administration
PR	potential cultural resources
Project	Twin Metals Minnesota Project

Q	quarter
QUM	Quaternary Unconsolidated Materials
RCRA	Resource Conservation and Recovery Act
RFSS	Regional Forester Sensitive Species
ROS	Recreational Opportunity Spectrum
SAG	semi-autogenous grind
SARA	Superfund Amendments and Reauthorization Act
SEH	Short Elliott Hendrickson, Inc.
SGCN	Species in Greatest Conservation Need
SHPO	State Historic Preservation Officer
SKA	South Kawishi Association
SKI	South Kawishiwi Intrusion
SNF	Superior National Forest
SO_2	sulfur dioxide
st	short ton
SWPPP	Stormwater Pollution Prevention Plan
TDS	total dissolved solids
TH	Trunk Highway
TMM	Twin Metals Minnesota LLC
U.S.	United States
µg/L	micrograms per liter
µS/cm	microSiemens per centimeter
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
yd^3	cubic yard

GLOSSARY

This glossary is intended to help the reader understand how Twin Metals Minnesota is using terms within this document. These are not intended to be legal definitions, nor are they intended to encompass or resolve the comprehensive and differing definitions and interpretations that can be found in federal, state, and local law and rule.

1854 Treaty Authority: An inter-tribal natural resource management agency that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of the Lake Superior Chippewa in the territory ceded under the Treaty of 1854.

access road: The primary road critical to TMM operations used to transport concentrate to market, transport reagents and consumables, and provide access to employees; the access road would be from the north of the plant site off Trunk Highway 1.

access road corridor: The standardized name for the corridor from Trunk Highway 1 to the plant site; this corridor would contain the access road for the project.

archaeological site: The physical remains of any area of human activity, generally greater than 50 years of age, for which a boundary can be established. Examples of such resources could include domestic / habitation sites, industrial sites, earthworks, mounds, quarries, canals, roads, etc. Under the general definition, a broad range of site types would qualify as archaeological sites without the identification of any artifacts.

acid rock drainage: A low pH, metal-laden, sulfate-rich drainage that occurs during land disturbance where sulfur or metal sulfides are exposed to atmospheric conditions. It forms under natural conditions from the oxidation of sulfide minerals and where the acidity exceeds the alkalinity. Non-mining exposures, such as along highway road cuts, may produce similar drainage. Also known as acid mine drainage when it originates from mining areas.

aquatic biota: Collective term describing the organisms living in or depending on the aquatic environment.

aquifer: A subsurface saturated formation of sufficient permeability to transmit groundwater and yield usable quantities of water to wells and springs.

attainment area: A geographic area considered to have air quality as good as or better than the National Ambient Air Quality Standards as defined in the Clean Air Act.

average: A measure of the statistical mean of the data set.

backfill plant: At the backfill plant, tailings filter cake would be repulped and blended with binder to create an engineered tailings backfill.

bedrock: The rock of the earth's crust that is below the soil and largely un-weathered.

berm: A mound or wall of earth.

best management practice: The schedule of activities, prohibition of practices, maintenance procedures, and other management practices to avoid or minimize pollution or habitat destruction to the environment. Best management practices can also include treatment requirements, operating procedures and practices to control runoff, spillage, or leaks; sludge or waste disposal; or drainage from raw material storage.

Boundary Waters Canoe Area Wilderness: This wilderness is a unique area located in the northern third of the Superior National Forest in northeastern Minnesota. It is approximately 1.3 million acres in size, extends nearly 150 miles along the International Boundary adjacent to Canada's Quetico Provincial Park, and is bordered on the west by Voyageurs National Park. The Boundary Waters Canoe Area Wilderness contains over 1,200 miles of canoe routes, 11 hiking trails, and approximately 2,000 designated campsites.

Clean Air Act (CAA): This Act defines the U.S. Environmental Protection Agency's responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer. The last major change in the law, the Clean Air Act Amendments of 1990, was enacted by Congress in 1990. This Act was incorporated into the United States Code as Title 42, Chapter 85.

Clean Water Act: This act is the primary federal law in the United States governing water pollution. The act establishes the goals of eliminating releases of high amounts of toxic substances into water, eliminating water pollution, and ensuring that surface waters meet standards necessary for human sports and recreation. This act does not directly address groundwater contamination. Groundwater protection provisions are included in the Safe Drinking Water Act, Resource Conservation and Recovery Act, and the Superfund Act.

closure: The process of terminating and completing final steps in reclaiming any specific portion of a mining operation. Closure begins when, as prescribed in the Permit to Mine, there would be no renewed use or activity by the permittee.

comminution circuit: Process circuit to reduce the particle size of ore.

Comprehensive Environmental Response, Compensation, and Liability Act: Commonly known as Superfund, this act was enacted by Congress on December 11, 1980 and created a tax on the chemical and petroleum industries and provided broad federal authority to respond directly to releases or threatened releases of hazardous

substances that may endanger public health or the environment. This law established prohibitions and requirements concerning closed and abandoned hazardous waste sites; provided for liability of persons responsible for releases of hazardous waste at these sites; and established a trust fund to provide for cleanup when no responsible party could be identified. The law authorizes two kinds of response actions**:**

- short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response; and
- long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on the U.S. Environmental Protection Agency's National Priorities List.

concentrate dewatering: Process circuit consisting of thickening and filtration to produce a concentrate filter cake that is ready for shipment.

concentrate storage and loadout: Temporary concentrate storage area at the concentrator before that would include a loadout area to load trucks with concentrate for shipment.

concentrator: A subset of the process related to recovery of the target metals, includes grinding, gravity flotation, concentrate dewatering, concentrate storage and loadout, and reagent makeup. The concentrator is located at the plant site.

concentrator services building: The building that would contain surface maintenance, warehouse, change rooms for concentrator and tailings dewatering plant operators, and offices.

construction stormwater: Direct precipitation or stormwater that has contacted surfaces disturbed during construction

contact water: Water, in the form of precipitation or stormwater runoff, that would potentially come in contact with ore or, tailings, or waste rock, but has not been used in the process or combined with process water.

contact water ditches: A ditch around the dry stack facility that collects runoff of the dry stack facility and directs it to the tailings management site contact water ponds. Additionally, the over-liner drain and under-liner drain are both directed to this ditch for conveyance to the contact water pond.

contact water ponds: Contact water ponds are built to manage contact water for the tailings management site and are named 1 through 5 from west to east.

contaminant: A substance that pollutes air, soil, or water. It may also be a hazardous substance that does not occur naturally or that occurs at levels greater than those found occurring naturally in the environment.

contaminate: To make (something) dangerous, dirty, or impure by adding something harmful or undesirable to it.

contamination: The intrusion of undesirable (i.e., unwanted physical, chemical, biological, or radiological) elements, or matter that has a negative effect on air, water, or land.

cultural resources: Archaeological, traditional, and built environment resources, including but not necessarily limited to buildings, structures, objects, districts, and sites.

dam: A structure that impounds water.

dBA: A-weighted decibel.

decibel: A unit expressing the relative intensity of sounds on a logarithmic scale from zero (for the average least perceptible sound) to approximately 130 (for the average level at which sound is perceived as painful to humans).

decline conveyor: The conveyor that would transport ore from the underground crushing stations up the decline to the transfer tower on the surface.

development rock: Sulfide barren rock mined from the hanging wall that would be used for construction aggregate. Development rock would be mined during the construction of the declines and ventilation raises, and periodically throughout the Project.

dike: A structure that directs the flow of water.

draindown: Water that would be collected in the dry stack facility over-liner drain.

dry stack facility: A dry stack facility is the most sustainable method used to store filtered tailings cake produced from the processing after the 4% of the ore that is copper, nickel, cobalt, platinum, palladium, gold, and silver is recovered. Since the tailings would be filtered and the majority of water is removed, a dry stack facility does not require a dam or berm. The dry stack facility would be a lined facility where the tailings filter cake (silty sandy material) is placed and compacted in lifts. The dry stack facility is constructed in three stages (stage 1, stage 2, and stage 3), generally from west to east.

ecological land type: A hierarchical level of the National Hierarchical Framework of Ecological Units and Ecological Classification System that is determined based on differences in vegetation, soils, climate, geology, and/or hydrology**.**

endangered species: A species that is in danger of extinction throughout all or a significant part of its range. This is a U.S. Fish and Wildlife Service formal listing under the Endangered Species Act.

environmental justice: The fair treatment and involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. "Fair treatment" means that no group, including racial, ethnic, and socioeconomic groups, will bear a disproportionate share of the negative environmental consequences resulting from the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to incorporate achieving environmental justice into their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.

engineered tailings backfill: Tailings which would be combined with a binder and pumped underground as a thickened slurry for placement in mined out stopes. The binder would increase the structural integrity, minimize movement of water, and enhance the chemical stabilization of the engineered tailings backfill.

environmental protection measures: Measures TMM would take to avoid, minimize, and/or mitigate potential effects.

filter cake storage and loadout building: The filter cake storage and loadout building would be located adjacent to the filter building. It would temporarily store tailings filter cake until it is loaded onto trucks and transported to the dry stack facility for placement.

filter plant: The facility that would produces tailings filter cake for placement on the dry stack facility or for use in backfill.

flotation circuit: Process circuit to recover the target metals into two flotation concentrates, a copper concentrate and a nickel concentrate. The waste product from this process is tailings.

fugitive dust: Airborn particulate matter. This can include emissions from haul roads, wind erosion, exposed surfaces, and other activities that remove and redistribute soil.

GAP land cover: A hierarchically organized vegetation cover map developed as part of the U.S. Geological Survey's Gap Analysis Program. Units of analysis are Minnesota Ecological Classification System subsections.

Giants Range: An outcrop of the Giants Range Batholith that forms a narrow surface ridge that strikes east-northeast.

Giants Range Batholith: A 2.68-billion-year-old granitoid batholith composed of silica-poor rocks ranging from diorite to quartz monzonite in composition.

gravity circuit: Process circuit within the comminution circuit used to recover dense minerals and produce the gravity concentrate.

groundwater: The water located beneath the ground surface in soil or rock pore spaces or fractures.

groundwater cutoff wall: The seepage cutoff trench with grout curtain as necessary depending on bedrock conditions surrounding the dry stack facility.

haul road: A specific subset of a service road that would surround the dry stack facility and be used by haul trucks to transport tailings filter cake onto the dry stack facility.

hazardous material: Any item or agent (biological, chemical, physical) that has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. The term includes hazardous substances, hazardous waste, marine pollutants, and elevated-temperature materials—materials designated as hazardous under the provisions of 49 Code of Federal Regulations 172.101. Hazardous material categories include explosives, gases, flammable liquids, flammable solids, spontaneous combustibles/dangerous when wet, oxidizers and organic peroxides, poisons and infectious substances, and corrosives.

hazardous waste: A category of waste regulated under the Resource Conservation and Recovery Act. Such waste includes solid waste listed in the Resource Conservation and Recovery Act that exhibits at least one of four characteristics (as described in 40 Code of Federal Regulations 261.20 through 261. 24): ignitability, corrosivity, reactivity, or toxicity; or that is listed by the U.S. Environmental Protection Agency in 40 Code of Federal Regulations 261.31 through 261.33.

hydrology: The study of water characteristics, especially the movement of water; or the study of water (including aspects of geology, oceanography, and meteorology).

invasive species: Organisms that cause, or are likely to cause, harm to the economy, environment, or human health due to their tendency to out-compete other species.

Laurentian Divide: A geological formation that runs along the crest of low, rocky hills and divides the Red River and Rainy River basins from the Minnesota River and Lake Superior basins. The Laurentian Divide is part of the Northern Divide, a continental divide that separates drainages to the Hudson Bay and Arctic Ocean from all other drainages in North America. Streams on the north slope of the divide flow through Canada to Hudson Bay. On the south side of the divide, streams flow south to either Lake Superior and the Atlantic Ocean, or the Mississippi River and the Gulf of Mexico.

L_{50}: Sound levels not to be exceeded 50 percent of the time.

laydown area: Area used for material and equipment storage during the construction phase of a project.

mine dewatering: Water that is pumped out of the mine from the underground sumps. Various water source can report to the sumps and they are mine inflow, engineered tailings backfill bleed water, engineered tailings backfill line flush water, dust suppression, and equipment water.

mine inflow: Groundwater that flows into the mine.

mine services building: The building that contains the truck shop, mine dry, and warehouse.

National Ambient Air Quality Standards: The Clean Air Act requires the U.S. Environmental Protection Agency to set these standards (40 Code of Federal Regulations Part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of these standards. *Primary standards* provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. *Secondary standards* provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

National Environmental Policy Act: This act (42 United States Code 4321 et seq.) was signed into law on January 1, 1970. The act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment and it provides a process for implementing these goals within federal agencies. The National Environmental Policy Act requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

National Register of Historic Places: The official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.

National Wetland Inventory: The U.S. Fish and Wildlife Service is the principal federal agency that provides information to the public on the extent and status of the Nation's wetlands. The Service has developed a series of topical maps to show wetlands and deep-water habitats. This geospatial information is used by federal, state, and local agencies, academic institutions, and private industry for management, research, policy development, education, and planning activities related to wetlands.

noise: Sound that interferes with speech and hearing and that is undesirable.

noise sensitive area: An area that, because of its use by humans or special status wildlife species and the importance of reduced noise levels to such use, is designated for management which limits the noise level from long-term and/or continuous noise producing sources.

non-contact stormwater: Stormwater that has not been affected by sulfides and metal leachates from oxidized rock exposed through mining.

non-contact water ditch: A ditch that would be constructed within the non-contact water diversion area to divert non-contact water around project features at the plant site and tailings management site.

non-contact water diversion area: A system of ditches and dikes which would be used to direct non-contact water away from the plant site and tailings management site.

non-contact water pond: A location where non-contact water would pond in the non-contact water diversion area after a diversion dike was installed to prevent surface water from flowing into the plant site or tailings management site.

off-site electrical substation: The electrical substation west of Dunka pit.

ore: Rock that contains the targeted metals which would be processed by TMM through the concentrator to recover targeted metals into three concentrates; ore is found in the basal mineralized zone of the Maturi deposit.

overburden: Waste material and/or rock covering a mineral deposit, or unconsolidated material covering bedrock.

overflow ore stockpile: The overflow ore stockpile would be located on the temporary rock storage facility and would serve to feed the concentrator during shutdowns of the underground mine and would exist intermittently during operations.

over-liner drain: A drain internal to the dry stack facility that would be installed above the liner that drains to the contact water ditch.

pH: A measure of relative acidity or alkalinity of a solution, expressed on a scale from 0 to 14, with the neutral point being 7. Acidic solutions have pH values lower than 7; basic (alkaline) solutions have pH values higher than 7.

plant site: The portion of the Project area that would encompass the following Project features: north contact water pond, central contact water pond, south contact water pond, process water pond, concentrator, temporary rock storage facility, pre-operational ore stockpile, overflow ore stockpile, concentrator services building, mine services building, and the plant site electrical substation.

plant site electrical substation: The electrical substation at the plant site.

platinum group metals: Platinum group metals are six chemical similar elements cluster together in the periodic table. The six elements are iridium, osmium, palladium, platinum, rhodium, and ruthenium. This definition has been expanded by the Project to also include gold and silver.

$PM_{2.5}$: Fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

PM_{10}: Inhalable particles, with diameters that are generally 10 micrometers and smaller.

pre-operational ore stockpile: During construction of the mine, before the concentrator is commissioned, ore would be temporarily stockpiled on the temporary rock storage facility. This stockpile on the temporary rock storage facility is the pre-operational ore stockpile.

process: The process terminology is used to discuss the process as a whole and is inclusive of the concentrator and tailings dewatering plant.

process water: Water that, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product.

process water pond: Centrally located pond west of the concentrator that would be used to store process water.

Project: The Twin Metals Minnesota Project. The Project would consist of the underground mine, the plant site, the tailings management site, the non-contact water diversion area, the access road, the water intake corridor and the transmission corridor.

Project area: An area that includes the proposed footprints of Project features and sufficient adjacent area to capture the surface environment potentially affected by Project ground disturbance.

proposed project: A proposed action, the results of which would cause physical manipulation of the environment, directly or indirectly.

reagent makeup: Process circuit dedicated to preparing reagents for use in the process.

reclamation: Activities that successfully accomplish the requirements of Minnesota Rules, parts 6132.2000 to 6132.3200. Actions intended to return the land surface to an equivalent undisturbed condition. Restoration of mined land to original contour, use, or condition. Steps or operations integral to mining that prepare the land for

post-mining use are called reclamation. When the objective of reclamation is to return the land to pre-mining conditions and uses, it is sometimes called restoration.

Resource Conservation and Recovery Act: This gives the U.S. Environmental Protection Agency the authority to control hazardous waste from “cradle-to-grave.” This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. This also sets forth a framework for the management of non-hazardous solid wastes. The 1986 amendments to the Resource Conservation and Recovery Act enabled the Environmental Protection Agency to address environmental problems that could result from underground storage tanks storing petroleum and other hazardous substances. These amendments also address storage and disposal of solid and hazardous wastes.

slurry: A watery mixture or suspension of fine solids (not thick enough to be considered sludge).

sediment pond: A pond used for settling suspended solids.

seepage: Water that may flow through the liner, independent of pathway.

standards: Samples containing a known amount of contaminant.

stormwater: According to Minnesota Rules, Part 7090, stormwater is defined as stormwater runoff, snow melt runoff, and surface runoff and drainage

suitable growth medium: A combination of topsoil, peat, and mineral soil.

tailings: Waste byproducts of mineral beneficiating processes other than heap and dump leaching, consisting of rock particles, which have usually undergone crushing and grinding, from which the profitable mineralization has been separated.

tailings dewatering plant: Includes the process facilities associated with the tailings thickener, filter plant, filter cake storage & storage loadout building, and backfill plant.

tailings filter cake: The tailings product resulting after pressure filtration; the tailings filter cake would have the majority of the water removed by the pressure filter.

tailings management site: The dry stack facility and other Project facilities in same geographic area.

tailings thickener: The equipment used to initially dewater tailings before being fed to the filter plant.

temporary rock storage facility: A lined facility at the plant site that would convey precipitation to the central contact water pond. The temporary rock storage facility is the physical infrastructure on which the pre-operational ore stockpile and the overflow ore stockpile would be located.

transmission corridor: The transmission corridor would be a corridor beginning at the off-site electrical substation located west of the Dunka River, extending northeast and terminating at the plant site electrical substation. The transmission corridor would include a two-track, unpaved maintenance road and the power transmission line.

under-line drain: A drain underneath the dry stack facility liner that would drain to the contact water ditch.

underground mine: This would include the underground workings as well as ventilation raise sites, ventilation raise site access roads, underground mobile equipment, and underground mine infrastructure.

underground mine area: The surface projection of the underground workings.

underground mine water: Water collected by the dewatering system including mine inflow (groundwater that flows into the underground mine), process water associated with the engineered tailings backfill; and mine supply water.

underground workings: This includes all underground excavations (i.e., ramps, haulage areas, drifts, stopes, and ventilation raises) beginning at the point the decline or raise goes below ground surface.

United States Forest Service Regional Foresters Sensitive Species: A list developed by the Regional Forester that identifies sensitive species. Sensitive species are defined as “plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by: (a) significant current or predicted downward trends in population numbers or density, and/or (b) significant current or predicted downward trends in habitat capability that would reduce a species’ existing distribution.” Sensitive species are usually designated for an entire region, but independent “Forest Sensitive” lists are maintained by some individual National Forests.

ventilation access road: An existing drill road would be upgraded in order to accessed ventilation raise site 1 and 2. Ventilation raise site 3 would be accessed via the existing forest service road, National Forest Road 1900. A portion of National Forest Road 1900 would also be used to access the upgraded drill road.

ventilation raise site 1, ventilation raise site 2, ventilation raise site 3: The ventilation raise sites serve as air intake and exhaust locations for the underground mine and are labelled from west to east.

waste rock: Rock mined during operations below the targeted cut-off grade that would be managed underground and placed in mined out stopes for permanent storage.

water table: The upper limit of the saturated zone (the portion of the ground wholly saturated with water); or the upper surface of a zone of saturation above which the majority of pore spaces and fractures are less than 100 percent saturated with water most of the time (i.e., the unsaturated zone) and below which the opposite is true (i.e., the saturated zone).

wetlands: Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence or vegetation typically adapted for life in saturated soil conditions. These generally include swamps, marshes, bogs, and similar areas.

wild rice: A tall aquatic annual grass of North America, bearing edible grain that typically grows in shallow lakes or slow-moving rivers and streams.

zoning ordinance: Locally adopted regulations that divide a town, city, village, or county into separate districts (e.g., residential, commercial, or industrial), define the permitted and prohibited land uses in those districts, and set forth specific development requirements (such as minimum lot size, height restrictions, etc.

1.0 OPERATOR INFORMATION

The names, addresses, and telephone numbers of those responsible for Project operations to whom notices and orders are to be delivered are identified in Section 1.1 and Section 1.2. Twin Metals Minnesota LLC (TMM) would notify the U.S. Department of the Interior Bureau of Land Management (BLM) Northeast States Office and the United States Forest Service (USFS) Superior National Forest (SNF) in writing within 30 calendar days of any change of operator or corporate point of contact or of any change in the mailing address of the operator or corporate point of contact.

1.1 Operator Information

Operator Name:	Twin Metals Minnesota LLC
Mailing Address:	380 St. Peter Street, Suite 705 St. Paul, Minnesota 55102
Telephone Number:	+1 651-842-6800
Fax Number:	+1 651-842-6801
Tax Payer ID:	42-1772768
Point of Contact:	Derek Heinecke
Emergency Contact:	Environmental Manager

1.2 Company Information

1.2.1 Chief Executive Officer

Full Name:	Kelly Osborne
Street Address:	380 St. Peter Street, Suite 705 St. Paul, Minnesota 55102
Telephone Number:	+1 651-842-6800
Fax Number:	+1 651-842-6801

1.2.2 Chief Regulatory Officer

Full Name:	Julie Padilla

Street Address:	380 St. Peter Street, Suite 705 St. Paul, Minnesota 55102
Telephone Number:	+1 651-842-6800
Fax Number:	+1 651-842-6801

1.3 Organizational Structure

TMM's organizational structure is illustrated in Figure 1-1.

2.0 DESCRIPTION OF OPERATIONS

The TMM Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, the Project targets valuable and strategic state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation. The Project location and general Project layout, consisting of an underground mine, a plant site, a tailings management site, and a non-contact water diversion area along with an access road, water intake corridor, and transmission corridor, are identified on Figure 2-1 and Figure 2-2, respectively. The surface disturbance of each of these Project features are summarized in Table 2-1. A simplified Project schematic is illustrated on Figure 2-3. Mineral tenure information is included in Appendix A.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations.

The purpose of this Mine Plan of Operations (MPO) document is to provide necessary information for the environmental review and permitting process. Specifically, this MPO addresses requirements for leasable minerals as per 43 Code of Federal Regulations (CFR) section (§) 3592 (Table 2-2). All references to federal and state statutes and regulations reference those in effect as of the date of filing.

The Project would develop an underground mine at the Maturi deposit. In the underground mine, the ore would be blasted using explosives. The blasted ore would be transported by load-haul-dump machines and haul trucks to underground crushers. The underground crushers would crush the ore to a smaller size for transportation out of the underground workings by conveyor.

The crushed ore would be fed to the concentrator to recover the targeted metals (copper, nickel, cobalt, platinum, palladium, gold, and silver) as concentrates. The first step in processing would be to further reduce the particle size of the ore through

grinding. The ground ore would be fed to the flotation circuit where sequential flotation would produce a copper concentrate and a nickel concentrate. A gravity concentration circuit would be installed to recover the higher density platinum, palladium, and gold minerals to a gravity concentrate. The three saleable products (copper concentrate, nickel concentrate, and gravity concentrate) would be dewatered through the use of thickeners and filters. The copper and nickel concentrates would be loaded into enclosed containers that would be transported by semi-trucks via public roads to a transload facility where the concentrate could be loaded to rail or boat for further transport.

During the flotation process, tailings would be produced as a waste byproduct. Tailings would no longer have economically recoverable copper, nickel, cobalt, platinum, palladium, gold, and silver as it would have been removed during processing. The Project would permanently store the tailings in two forms: as an engineered tailings backfill product used to fill the voids created by mining; and placed as a tailings filter cake to form a dry stack facility.

2.1 Background and History

Among copper, nickel, and platinum group metal deposits, the Duluth Complex ranks second in the world for contained copper and third in the world for contained nickel.

Grant (1899) and Nebel (1919) were the first to have noted the occurrence of copper sulfides in outcrops of the Duluth Complex. The first significant find of base metal mineralization in northern Minnesota was in 1948 by a local Ely prospector, F.S. Childers, in a road cut near the South Kawishiwi River on what is now the Spruce Road (Miller et al., 2002). Relatively contemporaneously, a similar copper-nickel mineralization was found in another road cut when driving down the Dunka Road about 10 miles (16 km) to the southwest. These two discoveries attracted the attention of at least 22 mineral exploration companies which began to drill the basal aspects of the Duluth Complex in 1952. Drilling has continued sporadically though to present day. From 1948 through 2000, more than 2,800 drill holes, totaling over 1.4 million feet (ft) (760,000 meters [m]) of core, were drilled in the Duluth Complex.

In 1953, the United States (U.S.) Bureau of Mines drilled three holes at Spruce Road. The Spruce Road deposit, the western and shallow northeast portions of the Maturi deposit, and Maturi Southwest were leased shortly thereafter by the International Nickel Company, Ltd (INCO). INCO drilled a total of 60 holes in the Maturi area from 1954 to 1970, totaling 57,614.4 ft (17,560 m) of drilling. From 1968 to1969, INCO sunk a shaft in the Maturi deposit to a depth of 1,095 ft (334 m). A 1975 INCO study refers to a 635 tonne sample of shaft material being sent off-site as a bulk mineralogical sample. There have been no records found that define the grade of the sample, grade of the concentrate produced, nor any indication of who conducted the subsequent metallurgical studies.

During this same period, several other exploration companies had leases and conducted limited deeper drilling and other exploration activities in the Maturi area on adjacent leases. These companies include Duval, Newmont, and Hanna.

From the mid-1970s to 2005, two holes were drilled in Maturi by Wallbridge Mining as a twin hole to INCO hole 11526. In 2006, Duluth Metals began drilling on the leases previously held by Duval and Newmont, referring to it as the “Maturi Extension” and later renaming it Nokomis. Duluth Metals entered a joint venture with Antofagasta PLC in 2010, rebranding the Project as Twin Metals Minnesota.

In 2011 the deposits were renamed back to Maturi. In 2015, Anatofagasta PLC subsequently acquired 100 percent (%) ownership of Duluth Metals. Today Antofagasta PLC owns 100% of Franconia (US) LLC, Twin Metals Minnesota LLC, and Duluth Metals.

2.2 Site Access

The Project would be accessed by a permanent access road (access road) which would extend from Highway (HWY) 1 (also known as Trunk Highway 1 [TH 1]) to the northern edge of the plant site, as illustrated in Figure 2-2. The access road is discussed further in Section 2.7. A typical cross section of the access road is included Figure 2-4.

2.2.1 Underground Mine

The underground mine would be accessed from portals located within the plant site. The portals would lead to two declines (Figure 2-5). Access to ventilation raise sites would be from an existing USFS road (National Forest Road [NFR] 1900) and exploration drill roads.

Existing exploration drill roads would be extended or upgraded to a single-lane unpaved road to create the ventilation raise access road as illustrated on Figure 2-2. A typical single-lane road cross section is included as Figure 2-6.

2.2.2 Plant Site

The plant site would be accessed from TH 1 via the access road (Figure 2-2). A staffed gatehouse would be located on the northern edge of the plant site to provide controlled access to the Project from the access road (Figure 2-5).

2.2.3 Tailings Management Site

The tailings management site is located directly to the south of the plant site, accessed via internal site roads (Figure 2-2 and Figure 2-7).

2.2.4 Non-Contact Water Diversion Area

The non-contact water diversion area would be accessed directly from the plant site and tailings management site via internal site roads (Figure 2-5 and Figure 2-7).

2.2.5 Water Intake Corridor

Access to the water intake corridor would originate from the plant site as illustrated on Figure 2-5. A typical cross section of the water intake corridor and associated access road is included as Figure 2-8. The water intake corridor is discussed further in Section 2.8.

2.2.6 Transmission Corridor

The transmission corridor would originate from an off-site electrical substation and terminate at the plant site electrical substation as illustrated on Figure 2-2. The transmission corridor would be accessed from the plant site, an existing road to the off-site electrical substation, or intermittently along the corridor from existing USFS roads. A typical cross section of the transmission corridor is included as Figure 2-9. The transmission corridor is discussed in further detail in Section 2.9.

2.3 Underground Mine

To achieve efficient recovery of the resource, underground mining at the Project would utilize the longitudinal longhole retreat (LLR) mining method with backfill. For this mining method, primary and secondary stopes (excavations in the underground mine) would be separated by sill pillars and rib pillars. The use of sill and rib pillars, as well as the backfilling of mined stopes with waste rock and engineered tailings backfill would provide confinement to the pillars between the stopes and ensure long-term stability of the underground mine. Additionally, to prevent subsidence, the Project would operate with an appropriate crown pillar depth.

Approximately 40% to 60% of the mineral resource within the designed underground mine would be left in sill and rib pillars for geotechnical stability purposes. These resources would be rendered un-minable by the LLR mining method at the cessation of mining operations. The recovery rates identified are a result of the economic feasibility of using the LLR mining method. The use of the LLR mining method was chosen as it allows for the long-term stability necessary for safe operations and the appropriate crown pillar depth to prevent subsidence. Mine stopes are generally designed around a proposed cutoff grade of 0.4% copper. However, all mineralized materials removed from the underground mine would be processed. Processing (as discussed in Section 2.4.4 and Section 2.4.5) would remove 70% to 94% of the targeted metals, depending on the metal (copper, nickel, cobalt, platinum, palladium, gold, or silver).

2.3.1 Portals and Declines

Two parallel declines, the conveyor decline (to the west) and the access decline (to the east), would be excavated to provide access to the subsurface orebody and underground workings. Each decline would be approximately 20 ft wide by 20 ft in height (6 m by 6 m).

To limit the distance of overland conveying from the portals, the decline portals would be located close to the coarse ore stockpile the temporary rock storage facility (Figure 2-5). Portal and mine decline development are discussed in Section 2.16.8.

Conveyor Decline

The conveyor decline would be the western of the two declines (Figure 2-5). The length of the conveyor decline from the portal to the initial haulage level tie-in would be approximately 1.6 miles (2.5 km). The conveyor decline would house the decline conveyor which would transfer ore from the mine to the surface and would eventually extend further down the deposit as mine development progresses.

After the conveying system is installed, the conveyor decline would provide a main exhaust path for the mine ventilation system and would serve as secondary access to the underground mine.

Access Decline

The access decline would accommodate access and egress of miners, equipment, and materials to operate the underground mine. Traffic would be two-way, with crosscuts to serve as access to the conveyor decline for emergency egress. This decline would provide a fresh air escape way, up-casting fresh air from the intake ventilation raises.

2.3.2 Blasting

A centralized blasting system would work in conjunction with the proposed digital leaky feeder system to provide full, two-way blast control for underground applications. This system would allow blasts to be initiated a safe distance from the blasting site.

Primary explosives products would include:

- Sensitized bulk emulsion;
- Electronic detonators; and
- Primers, boosters, and detonation cord.

Anticipated quantities of emulsion to be used for the Project are provided in Table 2-3.

2.3.3 Crushing and Underground Ore Handling System

Once drilled and blasted, load-haul-dump (LHD) equipment, either remotely or manually operated, would extract ore from the trough drift, through the drawpoint, and haul it to an orepass located in the extraction level.

The orepass would transfer ore from the extraction level to the haulage level where it would be rehandled by another LHD directly into a crusher or to a 40-ton truck that would haul the material to the closest crusher. Semi-portable jaw crushers would be located at crushing stations near the highest production orepasses. At the crushing stations, ore would be crushed to an approximate passing diameter of six inches (15 centimeters [cm]). The crushed material would then be conveyed to the decline conveyor via a transfer conveyor. The decline conveyor would transport ore to the coarse ore stockpile via the conveyor decline. A schematic of the underground workings is shown in Figure 2-10.

2.3.4 Backfill

Approximately 33 Million short tons (Mst) (30 Million tonnes [Mt]) of waste rock would remain underground as backfill and approximately 71 Mst (64 Mt) (40% of tailings) would be delivered underground for placement as engineered tailings backfill for a total of 104 Mst (94 Mt) of material backfilled into the mine (33 Mst + 71 Mst = 104 Mst or 30 Mt + 64 Mt = 94 Mt). Engineered tailings backfill production is described in Section 2.5.4.

Waste Rock Backfill

Waste rock from the underground development headings would be placed into stopes as backfill material and would generally be combined with engineered tailings backfill.

Engineered Tailings Backfill

Backfill Distribution System

Backfill distribution would be performed through one of the declines from the backfill plant located within the tailings management site (Section 2.5.4). From the main underground distribution point at the bottom of the conveyor decline, the engineered tailings backfill material would be distributed throughout the mine by pipes in the hanging wall. The underground distribution system would adapt to the mine plan as mining progresses through the various production areas.

Engineered tailings backfill material would be pumped into the stopes in two phases:

- Plug Pour - Phase I: A plug pour would be used to seal the drawpoint access in the stope. The drawpoint plug pour would be designed to fill the stope to

one m above the drawpoint brow. The plug pour must cure for an appropriate amount of time before the second phase of backfilling can proceed.

- Fill Pour - Phase II: Once the scheduled cure of the plug pour has lapsed, a fill pour would commence. The fill pour phase would utilize engineered tailings backfill with enough binder to prevent liquefaction. Upon completion of the fill pour, it must cure for an appropriate amount of time before adjacent stopes can be mined. The binder would increase the structural integrity, minimize movement of water, and enhance the chemical stabilization of the engineered tailings backfill.

Barricades

Barricades would be used as a means of backfill containment during backfilling operations. Two elevations would be available for barricade construction per stope: one barricade at the drawpoint and one barricade at the drill drift.

2.3.5 Mine Dewatering System

Underground mine water would report to dewatering sumps, including water from the following sources:

- Mine inflow (groundwater that flows into the underground workings);
- Process water associated with the engineered tailings backfill; and
- Mine supply water.

The mine inflow, a contributor to the mine dewatering rate, would change throughout the development of the underground workings.

Process water associated with the engineered tailings backfill would include engineered tailings backfill bleed water and engineered tailings backfill line flush water.

Mine supply water would be pumped underground from the process water pond and used for dust suppression and equipment requirements like drill water and satellite workshop wash bays. Excess mine supply water would be recaptured through a series of sumps.

Using collection sumps, face pumps, skid pumps, tank pumping stations, and secondary and primary pump stations, underground mine water would be pumped from the underground, de-oiled on the surface using oil-water separators and clarified in the sediment pond at the plant site. Excess water from the sediment pond not reused in the mine would report to the process water pond.

A portable slurry pump would be used to periodically sluice sediment from the sediment pond to the tailings thickener or other appropriate location for management and disposal.

2.3.6 Mine Ventilation System

Ventilation Raise Sites

The regulations of ventilation systems within underground mines in the United States are set by the U.S. Department of Labor, Mine Safety and Health Administration (MSHA). The minimum airflow requirement for a diesel-operating mine is relative to its fleet size, with airflow calculated to provide sufficient air for diesel particulate matter dilution.

The ventilation system is designed to operate as a “push-pull” system whereby ventilation raise site 2 would function as the intake raise area (with two intake raises) and ventilation raise site 1 and ventilation raise site 3 would function as the exhaust raises (Figure 2-2 and Figure 2-11). The ventilation raises would vary in size from 17 ft to 20 ft (5.3 m to 6 m) and would be sized to meet the ventilation system requirements. The ventilation raises would be constructed by raise bore technique. Dedicated ventilation drifts and internal raises would be established to transfer fresh and exhaust air from the production levels to the ventilation raises. Underground booster fans would be installed, as required, at the top of the fresh air transfer raises to support ventilation in the deeper parts of the mine.

Air would also exhaust through the conveyor and access declines. To serve as a third exit from the underground mine, an Alimak elevator (or a comparable product) would be installed in one of the intake ventilation raises.

Air intake and exhaust monitoring would be installed as necessary.

Level Controls

Airlocks, vent doors, regulators, and bulkheads would be used to ensure proper control of the air entering areas of the mine. In each extraction level, the proposed ventilation design considers an intake and exhaust source, with more air entering the level than exhausting through the return raise system.

Mine Heating

Due to the Project location, heating of the underground workings would likely be required from November through March or April. To heat the mine, TMM would use propane gas-fired air heaters located on the surface at ventilation raise site 2 (Figure 2-11). Fresh air would initially enter the heater house and pass through a direct-fired propane heater before being ducted to the main intake raise. A single propane tank storage facility for the heater stations would be located in close proximity to both heater stations, as illustrated on Figure 2-11. The facility would include multiple propane tanks. Tank sizing and quantity would be determined by the contracted propane supply company and would be based on peak propane consumption for a minimum of three days. Heaters are not required in the declines.

2.3.7 Underground Facilities

First Aid Stations

First aid stations would be distributed throughout the underground working areas. They would provide first-aid supplies for the care of minor injuries and for the stabilization of major injuries prior to transport to the surface. Stations would also contain communication equipment. First aid stations would be placed in excavations previously used as muck bays as well as in close proximity to refuge chambers.

Explosive Magazines

Underground explosive magazines would be excavations consisting of multiple bays to store: emulsion in portable cassettes; initiation caps and detonator cords; and high explosives (e.g., boosters, primers, and stick cartridge powder). Designated utility vehicles would transport explosives materials from the surface to the underground explosive magazines. The underground explosive magazines have been designed for a minimum of two days of explosive material storage. Storage and transport of explosives materials would be done in accordance with the MSHA, the U.S. Department of Justice, Bureau of Alcohol, Tobacco, Firearms and Explosives, and the Minnesota State Fire Marshall. Explosive magazines would have locked doors to restrict personnel access and would be in designated non-smoking areas. All magazines would be ventilated directly into an exhaust airway.

Underground Mobile Equipment

Primary Mining Equipment

Primary mining equipment would include the mobile equipment directly involved in the mining cycle including underground development and the haulage of muck and ore. The estimated primary mining equipment is listed in Table 2-4.

Secondary Mining Equipment

Secondary mining equipment would include equipment necessary for the safe and efficient continuation of the mining cycle but not directly involved in the mining cycle. Estimated secondary mining equipment would include:

- Cable bolters, shotcrete transmixers, and sprayers for ground support;
- Grader and water truck for roadway maintenance and dust suppression;
- Scissor lifts, boom trucks, and transmixers for underground construction;
- Mobile fuel and lubricant trucks to service mobile equipment; and
- Personnel carriers and light vehicles for transportation of workers, supervisors, and technical personnel.

Fuel and Lubrication Bays

Three underground fuel and lubrications bays, each including storage tanks and dispensing stations, would service the underground mining operations. Fuel would be delivered to the bays via a fuel pipeline delivery system. The fuel transfer pipeline from the surface would use an automated batch transfer system with automated valves to direct fuel to the demand location. The amount of fuel stored at each location would vary depending on the equipment schedule. At a minimum, each would have the capacity to store one day's usage.

Lubrication oils and grease totes would be transported underground to the fuel and lubrication bays. All fuel and lubrication bays would include fire suppression systems.

Underground fuel / lube trucks would be available to service equipment at the development and production faces. This includes drill jumbos, production drills, bolters, graders, shotcrete spray units, and portable compressors.

Satellite Maintenance Workshops

Satellite maintenance workshops would provide light mechanical repairs for slower moving mobile equipment (e.g., jumbos, bolters, and production drills). Satellite workshops would be constructed underground as required to minimize travel delays and facilitate equipment turnaround times. Lubrication oil and grease totes would be transported underground to the satellite maintenance workshops, as needed.

Communication Systems

Underground communications would be based on a redundant backbone system along the conveyor and access declines and main ramps by means of fiber optic and leaky feeder. A leaky feeder system consists of a coaxial cable which emits and receives radio waves like an extended antenna. The extension of communication systems to the extraction and drilling areas would be with a leaky feeder system.

A fiber optic system would allow for the communication of live video feed from the crushers and conveyors, surveillance video from explosive magazines and backfill bulkheads, plus data from control rooms.

The leaky feeder system would carry all radio and internet protocol signals (with the use of modem converters). The leaky feeder system would also connect and pass information to the fiber optic system for faster and more reliable communication.

Radios would be installed in underground equipment and handheld radios would be issued to supervisors and crew leads.

Anticipated communications systems may be modified and/or upgraded as practicable and necessary based on available technologies.

Refuge Chamber

In the event of an emergency, refuge chambers would provide mine workers with a safe atmosphere for up to 36 hours. Refuge chambers are discussed in Section 2.3.7.

Lavatories

Portable lavatories (blue rooms) would be supplied for the underground operations and would be placed in close proximity to general work areas. Sewage from the blue rooms would be collected via vacuum pump trucks, transported to the surface, and disposed of off-site by a licensed third-party contractor.

Office and Waiting Areas

The underground office and waiting area would include a break room with drinking water and tables, as well as a small office space for supervisors to complete administrative work for the underground operations.

Fire Detection System

The underground mine would be equipped with a fire alarm, control and suppression system as required.

Power Distribution

For the underground mine, electrical power would originate at the portals and be routed down the declines to the main underground switchgear. From the main switchgear, distribution lines would distribute power throughout the underground mine.

Localized underground transformers would step the power down to usable voltages. The feeders for underground services would be sized to provide redundant service for the major ventilation equipment and other equipment critical to personnel safety or production.

Electrical power to the vent raises would be supplied through the underground distribution lines, so as to limit the need for surface facilities and minimize surface disturbance footprints.

2.4 Plant Site

The overall process flow diagram is presented in Figure 2-12.

2.4.1 Ore Storage Facilities

There would be two ore storage facilities on the surface: the coarse ore stockpile and the temporary rock storage facility.

Coarse Ore Stockpile

The concentrator would be fed with ore from the coarse ore stockpile where it would be reclaimed by the coarse ore reclaim conveyor (also known as the semi-autogenous [SAG] mill feed conveyor). The coarse ore stockpile would primarily be fed by run of mine ore from the decline conveyor via the coarse ore stockpile feed conveyor but would also be supplemented with ore from the pre-operational ore stockpile during the first two years of operation and intermittently supplemented with ore from the overflow ore stockpile during operational years three through 25.

The coarse ore stockpile would have a concrete working floor with a reclaim area underneath the working floor, and a covered geodesic dome structure. The coarse ore stockpile would be approximately 94 ft tall and would have the capacity to store up to three days of crushed ore. Covering the coarse ore stockpile would reduce dust emissions, prevent infiltration of stormwater into the ore, and would reduce the risk of ore freezing during winter operations.

Material from the coarse ore stockpile would be fed into the concentrator via the SAG mill feed conveyor. Ore stored in the coarse ore stockpile would already be crushed and would be fed directly to the SAG mill within the comminution circuit without additional crushing. The coarse ore stockpile's geodesic dome would be located beneath the coarse ore stockpile feed conveyor to reduce the visibility of the dome. Primary access would be along the SAG mill feed conveyor. A secondary escape would be included in the tunnel under the coarse ore stockpile which would contain the apron feeders and a portion of the SAG mill feed conveyor.

Temporary Rock Storage Facility

The temporary rock storage facility would be a lined facility with water management features which would capture stormwater on the footprint of the facility to direct it to the central contact water pond. At the central contact water pond, the water would be pumped to the process water pond for process use. Throughout the life of the Project, two stockpiles would be managed on the temporary rock storage facility: the pre-operational ore stockpile and the overflow ore stockpile.

The temporary rock storage facility would be lined with an 80 mil linear low-density polyethylene (LLDPE) or engineer-approved alternate geomembrane liner, overlain by 12 inches (300 millimeters [mm]) of compacted low permeability soil, and 12 inches (300 mm) of sand (Figure 2-13).

Pre-operational Ore Stockpile

Ore extracted during mine development would be temporarily stockpiled as the pre-operational ore stockpile located on the surface on the temporary rock storage facility. The pre-operational ore stockpile would be processed through the concentrator as part of the feed material for concentrator ramp-up and initial production.

Once the concentrator is commissioned, the pre-operational ore stockpile would be re-handled, crushed at a temporary surface crushing facility, and fed into the coarse ore stockpile via conveyors for processing through the concentrator. The pre-operational ore stockpile would be temporary and at its largest size (1.2 Mst) at the end of the mine construction period. The pre-operational ore stockpile would be consumed through the process within the first two years of operations. Design parameters for the pre-operational ore stockpile are included in Table 2-5.

Overflow Ore Stockpile

After processing the pre-operational ore stockpile on the temporary rock storage facility, a portion of the temporary rock storage facility would be used to manage the overflow ore stockpile. The overflow ore stockpile would operate with a capacity of up to 2.5 days of crushed ore and would be used intermittently throughout the mine operation. The overflow ore stockpile would serve to decouple the underground mine and process plant during shutdowns. Shutdowns would occur due to both planned and unplanned maintenance.

When the coarse ore stockpile is temporarily full, crushed ore would be directed via conveyor to the overflow ore stockpile. When space is available in the coarse ore stockpile, ore in the overflow ore stockpile would be reclaimed by front end loader before being placed on the temporary rock storage facility reclaim conveyor and directed to the coarse ore stockpile feed conveyor via the surface transfer station. Intermittent use of the overflow ore stockpile would be based on the maintenance schedule of both the underground mine and the process plant.

2.4.2 Surface Conveyors

Coarse Ore Stockpile Feed Conveyor

The coarse ore stockpile feed conveyor would transfer ore to the coarse ore stockpile from either the decline conveyor or the temporary rock storage facility / overflow ore stockpile reclaim conveyor via the surface transfer station. The coarse ore stockpile feed conveyor would be equipped with a weather cover to reduce freezing, noise, and dust emissions. The coarse ore stockpile feed conveyor would be self-supported and would be mechanically and structurally independent of the coarse ore stockpile's geodesic dome. The coarse ore stockpile feed conveyor would have enough clearance to drive trucks beneath in designated areas.

Temporary Rock Storage Facility Reclaim Conveyor

When processing ore from the pre-operational ore stockpile during startup of the concentrator, the temporary rock storage facility reclaim conveyor would feed crushed ore from the temporary crusher near the temporary rock storage facility to the coarse ore stockpile feed conveyor via the transfer station. This conveyor would be used intermittently during operations.

Temporary Rock Storage FAcility Feed Conveyor

When the coarse ore stockpile is full, ore from the decline conveyor would be diverted to the overflow ore stockpile on the temporary rock storage facility via the transfer station and temporary rock storage facility feed conveyor. This conveyor would be used intermittently during operations to feed the overflow ore stockpile.

Coarse Ore Reclaim / SAG Mill Feed Conveyor

Ore would be reclaimed from the coarse ore stockpile by two apron feeders and would be discharged onto the SAG mill feed conveyor. The SAG mill feed conveyor would transfer ore to the concentrator building from the coarse ore stockpile. The SAG mill feed conveyor would be equipped with a weather cover and water spray dust control system at transfer points.

2.4.3 Concentrator Building

The concentrator building would include the comminution circuit, flotation circuit, concentrate dewatering, concentrate storage and loadout, and the reagent makeup area (Figure 2-5). These areas are located inside the building and are sited together to allow for a centralized control room and better control of the processing. The concentrator control system is discussed in Section 2.4.7. Buildings on surface, including the concentrator building, would be equipped with a fire alarm, control and suppression system as required.

2.4.4 Comminution Circuit

The comminution circuit would be located within the concentrator building. The comminution circuit would use a SAG mill and ball mill configuration to reduce the particle size of the ore prior to the flotation circuit. Within the comminution circuit would be the gravity recovery circuit to recover gold, platinum, and palladium. The major sub-circuits of the comminution circuit are further discussed in this section. The grinding circuit and gravity circuit are further discussed in this section.

A bridge crane would span the concentrator building to service the SAG mill, ball mill, and SAG discharge screen. Another bridge crane would service the gravity concentrate circuit. A liner handling machine would be required for the SAG mill. The grinding circuit and bridge cranes have been designed to reduce the height and subsequent visibility of the concentrator building.

Grinding Circuit

The SAG mill feed conveyor would convey ore from the coarse ore stockpile to the SAG mill to be processed. Ore from the coarse ore stockpile along with recirculated oversize material would feed the SAG mill. The SAG mill discharge would be screened and oversize pebbles would be conveyed and reintroduced to the SAG mill feed on the SAG mill feed conveyor. Recirculation conveyors for oversize material would be contained within the building to keep the wet ore on the conveyor belt inside the building to prevent potential freezing during winter. SAG mill discharge material which passes through the screen would have achieved the target grind size from the SAG mill circuit and would be directed to the ball mill circuit.

The ball mill circuit would grind ore to a P_{80} of 135 microns before the ore is pumped to the flotation circuit. The ball mill would be operated in a closed-circuit configuration to achieve a tight particle size distribution. The ball mill circuit would be fed from the product of the SAG mill circuit (the screened undersized material from the SAG mill discharge) combined with material being recirculated to the ball mill (the ball mill recirculating load). This stream would then be classified through a cyclone with the cyclone overflow as the product of the circuit being pumped to the flotation circuit. The cyclone underflow would be recirculated to the ball mill to be ground and further reduced in size.

A portion of the ball mill recirculating load would be split and fed to the gravity concentration circuit before returning to the ball mill circuit.

Gravity Concentration Circuit

A portion of the ball mill recirculating load would be split equally to feed multiple gravity concentration units operating in parallel. The gravity concentration units would operate in batch to recover gold, platinum, and palladium based on the higher specific gravity of the minerals to the gravity concentrate. The gravity concentrate would be dewatered while the gravity tailings would be returned to the ball mill recirculating load.

The gravity concentrate would flow in batches to a gravity concentrate holding tank. The gravity concentrate would be dewatered and transferred to concentrate bags or other containers. The concentrate bags or containers could be stored or loaded onto trucks for transport.

2.4.5 Flotation Circuit

The flotation circuit would produce two concentrates: the copper concentrate and the nickel concentrate. Through the copper flotation circuit, copper, gold, silver, platinum, and palladium would be recovered while minimizing the amount of nickel and cobalt recovered. Through the nickel flotation circuit, nickel, cobalt, and the remaining copper, platinum, palladium, gold, silver, and the remaining sulfides would be recovered.

The copper and nickel flotation circuit would be located in the concentrator building and would include a copper rougher bank, nickel rougher bank, copper and nickel regrind mills, copper cleaners, and nickel cleaners.

Copper Rougher

Overflow from the ball mill cyclone feed cluster would be directed to the copper roughers. Reagents would be added to the copper rougher bank to promote flotation of copper minerals. Through flotation, a majority of the copper minerals would be recovered into a copper rougher concentrate while the material that does not float would report to the copper rougher tailings. The copper rougher tailings would still contain the majority of nickel minerals and some left over copper minerals. The copper rougher tails would be sent to the nickel rougher bank to recover nickel and cobalt minerals and the remaining copper minerals. The copper rougher concentrate would be pumped to the copper concentrate regrind mill for particle size reduction prior to grade improvements through counter-current cleaning.

Copper Regrind

The copper rougher concentrate would be further reduced in particle size to increase liberation before being fed to the copper cleaning circuit.

Copper Cleaners

The copper regrind mill discharge would feed the copper cleaner circuit. The copper cleaner circuit would include two stages of counter current cleaning where the copper concentrate grade would be improved to target product specifications. The final concentrate would be pumped to the copper concentrate dewatering circuit and the copper cleaner tailings would be pumped to the nickel regrind circuit.

Nickel Rougher

The copper rougher tailings would feed the nickel rougher. Reagents would be added to the nickel rougher bank to promote flotation of nickel and cobalt minerals and the remaining copper minerals. Through flotation, nickel and cobalt minerals and the remaining copper minerals would be recovered into a nickel rougher concentrate while the material that did not float would report to the nickel rougher tailings. At this point, the nickel rougher tailings would contain no more recoverable metal or recoverable sulfide minerals and would be pumped to the tailings dewatering plant in preparation for placement on the lined dry stack facility or use as backfill material. The nickel rougher concentrate would be recovered and sent to the nickel regrind circuit.

Nickel Regrind

The nickel rougher concentrate would be further reduced in particle size to increase liberation and would then be combined with the copper cleaner tailings before being fed to the nickel cleaning circuit.

Nickel Cleaners

The nickel regrind mill discharge would feed the nickel cleaner circuit. The nickel cleaner circuit would include three stages of counter current cleaning where the nickel concentrate grade would be improved to target product specifications. At the end of the first stage of nickel cleaning, the final cells would act as a scavenger to keep recoveries high. The final concentrate would be pumped to the nickel concentrate dewatering circuit and the nickel cleaner tailings would be pumped to the thickener at the tailings dewatering plant.

2.4.6 Concentrate Dewatering and Storage

The final copper concentrate and final nickel concentrate would each be dewatered and stored in circuits dedicated to each concentrate to prevent cross contamination.

Copper and Nickel Concentrate Dewatering

The final concentrates from the flotation circuit would first be dewatered through dedicated concentrate thickeners to remove a majority of the water and produce thickened concentrates. The thickeners would be located inside the concentrator building to prevent freezing during winter months

The thickened concentrates would be fed to dedicated concentrate filter presses. The filter presses would reduce the moisture in the concentrates and allow the concentrates to be stockpiled and then transported by truck, rail, or ship. Filtered concentrates would be discharged to the dedicated storage and loadout area.

Filtrate from the concentrate filter presses would be returned to the concentrate thickeners to further clarify the water. Thickener overflow water would be used to make up immediate process water needs in the concentrator with the excess being sent to the process water pond where it would be reused for processing of ore at the concentrator.

Copper and Nickel Concentrate Storage and Loadout

The filtered copper and nickel concentrates would drop into their respective loadout areas. To prevent cross contamination, the concentrates would be handled by dedicated front end loaders to load either copper or nickel concentrate into their respective concentrate trucks. The loadout areas are designed for three days of storage each of copper and nickel concentrate.

2.4.7 Plant Site Surface Infrastructure and Ancillary Facilities

Mine Services Building

The mine services building would include a truck shop, mine dry, and warehouse. The mine services building would be centrally located and would be shared by technical services, supervision, and hourly labor for the underground mine (Figure 2-5).

The truck shop portion of the mine services building would service underground vehicles, maintenance service vehicles, and some utility vehicles. Although some minor maintenance would be performed underground in satellite maintenance workshops by underground service vehicles, most maintenance would require mobile equipment be brought to the surface. Haulage trucks, powder trucks, and services vehicles would drive out of the underground mine to the truck shop using their own power. Others, such as development and production drills, loaders, and bolters would be transported out of the underground mine to the truck shop on low-boy trailers. Light vehicles would generally be serviced off-site, or as time and space allots, at the plant site. The truck shop portion of the mine services building would host the following facilities:

- Overhead crane;
- Wash bays;
- Lubricant and oil storage;
- Welding bay;
- Tool crib; and
- Space allotted outside for parking vehicles.

Engine oil and lubricants would be provided in oil cubes and stored in dedicated areas near the mine services building. Primary fuels for the Project are provided in Table 2-6. These would be stored in dedicated areas on surface and within the underground mine.

The mine dry portion of the building would host the following facilities:

- Mine personnel drys with clean and dirty sides (complete with baskets);
- Laundry staging area (laundry would be collected for cleaning by a third-party contractor);
- First aid / security;
- Storage;
- Offices adjacent to an open concept area for technical services;
- Lunch / training room;
- Space for daily safety meetings; and
- Mine rescue training and storage room.

The warehouse portion of the building would host the following facilities:

- Storage area for mine equipment maintenance spares;
- Small office for the receivables team;
- Truck unloading dock; and
- Storage with shelving.

Concentrator Services Building

The concentrator services building would be located near the concentrator building and would provide a workshop to perform routine and non-routine maintenance on concentrator building equipment, as well as store critical and non-critical spares (Figure 2-5). The concentrator services building would host the following:

- Maintenance workshop, including a machine shop, welding shop, tool crib, mechanical room, overhead cranes, and electrical repair room;
- Indoor warehouse facility with unloading dock and shelving;
- Locker and change facilities for process operators;
- Offices, both on the ground floor and in an elevated floor on the north side of the building; and
- Lunch and training rooms.

The concentrator services building would also include an attached covered work area and a fenced storage area.

Process and Contact Water Facilities

The process water facilities are discussed in Section 2.13.3 and contact water facilities are discussed in Section 2.13.5.

Reagent Storage

Reagents for flotation and thickening would be made up in an extension of the concentrator building near the flotation circuit (Figure 2-5). Reagents delivered in bulk solution would have dedicated storage tanks within the extension. Reagents delivered in bulk bags would be stored in the fabric-covered reagent storage building adjacent to the concentrator services building. Lime would be stored in a silo outdoors and would be integrated with the detention slaker. The minimum reagent storage would be one week, except for lime which would be approximately 4.5 days. Primary reagents required for mineral processing are provided in Table 2-7.

Grinding Ball Storage

Grinding media would be shipped to the site via bulk transport and stored in ball bunkers which would provide up to four weeks of storage. The grinding ball storage would be near the concentrator building, as shown on Figure 2-5.

Laboratory

Metallurgical and geological assays would be contracted to a third-party laboratory in the region. An on-site laboratory would be located in the concentrator building and would be used for grinding tests, flotation tests, and geotechnical tests.

Gatehouse

The access road would provide access to the northern portion of the plant site, where a staffed gatehouse would control access as shown on Figure 2-5.

Tire Wash

Roads within the plant site would be divided into contact roads and non-contact roads, as related to water management. Contact roads would be used for mine operations and non-contact roads would be used for site navigation and are intended for use by vehicles not directly related to production or maintenance.

Vehicles which use a contact road must go through the tire wash before exiting back to the non-contact roads to prevent possible contaminants from leaving the site. The tire wash would be located near the parking area as shown on Figure 2-5.

Snow Storage

During winter months, snow would be plowed into designated snow storage areas (Figure 2-5). These snow storage areas have been designed to accommodate a snow water equivalent of between 7.3 to 11.9 inches (185 to 301 mm).

Ready Line

When not in use, haul trucks and other mobile mine equipment would be temporarily staged at the ready line located near the mine services building as illustrated on Figure 2-5. The equipment would be parked here during shift changes and when requiring light maintenance. The area would be lit at night for safety.

Parking

Employees would be bussed to the site from the administration building located in Babbitt (Section 2.19.1) or from a parking lot in Ely and would not require parking spaces within the plant site. Parking areas would be located adjacent to the mine services building and concentrator services building for use by supervisory staff, project technical staff, contractors, and consultants.

Laydown Areas

Equipment and materials not requiring climate-controlled storage would be stored in construction laydown areas. Sea containers and temporary shelters may be used for

goods that require weather protection. Laydown areas would be located throughout the plant site. Laydown areas during both construction and operation would be designated within the plant site or tailings management site as appropriate.

Mine Water Supply

Mine water supply is discussed in detail in Section 2.12.

Explosive Magazines

Explosives would be temporarily stored on the surface prior to transport to the underground explosive magazines. The location of the surface explosive magazine is shown on Figure 2-5.

Shotcrete Plant and Aggregate Stockpile

The shotcrete plant and aggregate stockpile would be located to the east of the coarse ore stockpile. The shotcrete plant would consist of a mobile mixing unit for maximum operational flexibility. The shotcrete plant would be erected on steel foundations.

Shotcrete would be used in the underground workings. Cement trucks would be filled with shotcrete on the surface and driven underground to required locations.

Reclamation Material Stockpiles

Suitable growth medium, which includes topsoil, peat, and mineral soil, would be stripped from the site and stockpiled for future reclamation efforts.

Topsoil would be stored in two stockpiles at the plant site (reclamation material stockpile 1 and reclamation material stockpile 2 as illustrated on Figure 2-5). Topsoil stripping at the plant site is estimated to produce 111,200 cubic yards (yd^3) (85,000 cubic meters [m^3]) of material based on soil surveys of the area. Plant site reclamation material stockpile dimensions are shown in Table 2-8.

During clearing and grubbing, saleable lumber would be harvested and sold by a licensed, third-party contractor. The remaining plant matter would be chipped and used to cover the reclamation material stockpiles to prevent wind and water erosion. Waddles would also be placed around the base of the reclamation material stockpiles for stormwater control. Additional woodchips would be strategically placed in the laydown yards for future use.

Communication System

On-site communications would be conducted through a fiber-optic system. The fiber-optic system would be connected to major buildings. Vehicle communications would be provided by short wave radio in surface vehicles for communication to operations.

Off-site communication would be performed primarily by cell phone and voice over internet protocol. The communication system for underground operations would rely on fiber optic, leaky feeder, and radios as discussed in Section 2.3.7. The mine communication system would be integrated with the mine's control system.

Control System

The plant site would be monitored and controlled from a central control room located in the concentrator building and the tailings management site would be monitored and controlled from a satellite control room located in the filter plant. A process control system would be integrated across the entire site and would provide different monitoring, control, and access permissions for different areas.

Surface Mobile Equipment

Surface mobile equipment would support the plant site, tailings management site, and general surface operations. Surface mobile equipment are identified in Table 2-9. Note, the surface mobile equipment does not include mobile equipment for services that TMM plans to contract such as employee bussing and snow removal.

Fuel and Lubricant Storage

Diesel and gasoline for the plant site would be stored near the mine services building within the fuel storage area (Figure 2-5). A gasoline tank would allow fueling of surface equipment and/or light vehicles. The diesel tank would be sized to allow for a minimum of one week of consumption for both surface and underground users. The diesel and gasoline would be stored in appropriately sized containment areas in accordance with state and federal regulations. The gasoline and diesel tanks would have a local dispenser.

Diesel would be pumped to the portal in batches and gravity-fed to the underground storage tanks via a fuel pipeline delivery system installed in the conveyor decline, as described in Section 2.3.7. The system would include controls and instrumentation to ensure safety interlocks and transfer protocols are observed.

Propane would be used to heat the mine and Project facilities. Propane storage for heating of the underground workings would be located at ventilation raise site 2 (Figure 2-11) and provide for a minimum of three days of use, as discussed in Section 2.3.6. Propane for heating other facilities would be located adjacent to the concentrator building (Figure 2-5).

Electrical Substation and Mine Electrical System

Plant Site Power Distribution

A TMM-owned transmission line would supply power to the plant site electrical substation. Distribution across the plant site and tailings management site would utilize underground raceways, cable trays, and overhead power lines to connect the following areas:

- Concentrator building;
- Backfill plant building;
- Filter plant building;
- Mine services building;
- Concentrator services building;
- Coarse ore stockpile;
- Portals and declines;
- Underground mine; and
- Other lesser ancillary facilities.

Electrical equipment, motors, control panels, field devices, relay control system components, and cabling systems would be approved for the environmental conditions in which the equipment would be installed. Oil-filled electrical equipment (transformers, switch gear, etc.) would be certified polychlorinated biphenyl free before being brought on-site.

Backup Power

In the event of a power outage, production would be halted and backup power would be provided for emergency services through standby power generators rated for the maximum power required in the event of a utility power failure; the standby power generators would be sized to provide approximately 2.5 MW, but would be updated as deemed necessary to reliably provide site emergency power. Backup power loads would be controlled through the process control system which would automatically start and stop loads to keep process pumps operating to prevent spills and overflows, keep tanks properly agitated, and run critical equipment such as fans for safe ventilation.

Uninterruptable power supplies would be used to provide backup power to critical control systems. This equipment would be sized to allow operations to shut down and back up the computer and control systems and to facilitate start-up on restoration of normal utility power. Emergency battery power packs would supply back-up power to the fire alarm system and emergency egress lighting fixtures.

Telecommunications

Telecommunications service would be required to support the Project. The delivery of telecommunications is still being studied. Potential options for connecting to existing telecommunications network include, providing service through a cable routed with the transmission corridor, providing service through a cable routed with the access road corridor, or satellite service options.

Fencing

Fencing would be installed around the plant site, tailings management site, and associated solution ponds, as necessary. Additionally, infrastructure such as the ventilation raise sites and the water intake facility would be fenced to control access. Fencing specifications would be in accordance with guidance set forth by the MDNR and USFS.

2.5 Tailings Management Site

As discussed in Section 2.4.5, tailings from the nickel rougher would be pumped from the concentrator to the tailings dewatering plant which includes the tailings thickener, filter plant, filter cake storage and storage loadout building, and backfill plant.

2.5.1 Tailings Thickener

The tailings thickener would be located adjacent to the filter plant (Figure 2-7). The tailings supply line would follow a service road connecting the plant site and the tailings thickener. In addition to the tailings supply line, power, water supply, and water return lines would be routed alongside the service road connecting the plant site and the tailings thickener. The Project would be capable of producing 100% tailings filter cake for the lined dry stack facility, 100% engineered tailings backfill backfill, or different proportions of each.

A flocculant reagent would be added to the tailings thickener to aid in the tailings settling and dewatering. The thickened tailings from the tailings thickener underflow would be sent to the filter plant for further dewatering. Tailings filter cake from the filter plant would then be placed on the lined dry stack facility or sent to the backfill plant and combined with a binder for use as engineered tailings backfill in the underground workings in different proportions depending on operational needs.

The tailings thickener would be a steel supported above-ground structure and, should a loss of containment occur, slurry would flow to a lined emergency pond located adjacent to the thickener (Figure 2-7).

The filter plant is discussed in Section 2.5.2 and the backfill plant is discussed Section 2.5.4.

2.5.2 Filter Plant

The filter plant would be located in the northwest corner of the tailings management site adjacent to the tailings thickener, backfill plant, and the filter cake storage and loadout building (Figure 2-7). The filter plant would consist of filter feed tanks, process water holding tanks, pressure filter presses, and ancillary equipment including air compressors, pumps, and tanks. The filter units would receive thickened

tailings slurry from the tailings thickener via feed tanks and produce a tailings filter cake in the target range of 84% to 87% solids. The tailings filter cake would be transported via short-run conveyors to either the backfill plant or the filter cake storage and loadout building.

2.5.3 Filter Cake Storage and Loadout Building

The filter cake storage and loadout building would receive tailings filter cake from the filter plant via a belt conveyor which would deposit the material onto a radial stacker. The radial stacker would be used to create a stockpile with up to 1.5 days of tailings storage capacity as a tailings filter cake (Figure 2-7). The stockpile would be enclosed in the heated building to prevent dust, rewetting due to stormwater, and freezing due to cold temperatures. Front end loaders would transfer the stockpiled tailings filter cake material from the stockpile into haul trucks which would transport the tailings filter cake to the lined dry stack facility. A haul road would exist alongside the filter cake storage and loadout building and would be used as the transportation route to the lined dry stack facility.

2.5.4 Backfill Plant

Tailings thickener underflow which bypasses the filter plant would be recombined with tailings filter cake, sent to the backfill plant, and blended with a binder for use as engineered tailings backfill in the underground workings (Figure 2-7). Blended tailings from the backfill plant would be delivered as engineered tailings backfill to mined out stopes in the underground workings via a pipeline distribution system utilizing positive displacement type pumps. Additional information regarding backfill is included in Section 2.3.4.

2.5.5 Dry Stack Facility

The lined dry stack facility would provide permanent storage of tailings filter cake and would be located within the tailings management site (Figure 2-7). The dry stack facility footprint preparation and construction is discussed in Section 2.16.4. The dry stack facility would be developed by placing and compacting approximately 106 Mst (96 Mt) of tailings filter cake, which amounts to approximately 60% of the total tailings which would be generated by the Project. The lined dry stack facility would have a tailings storage footprint area of 429 acres (174 hectares [ha]) to the toe of the dry stack facility (edge of tailings). The dry stack facility would average 130 ft tall with a crest elevation of 1,621 ft above mean sea level (amsl) at full development. Associated features would be located around the perimeter of the dry stack facility, including ponds and ditches to manage contact water, a groundwater cutoff wall, haul roads, and a reclamation material stockpile.

As discussed in Section 2.5.3, tailings filter cake would be transported from the filter cake storage and loadout building to the lined dry stack facility by haul trucks travelling over constructed haul roads. The tailings filter cake would be dumped by the haul trucks on the dry stack facility, levelled by dozers, and compacted with

vibratory roller compactors or other equipment as required. The exterior side slopes would have 16 ft (5 m) wide benches at 46 ft (14 m) vertical intervals. The exterior slopes would have an overall slope of 4H:1V. Benches would provide a location for collection channels and would be graded towards regularly spaced discharge chutes extending down the slopes of the dry stack facility, that would be constructed as part of the reclamation landscape. Overall, the filtered tailings would be compacted and placed at grades and contours that would promote drainage, prevent ponding, and allow for stability in post-closure.

The lined dry stack facility would consist of a zone of densely compacted tailings filter cake around the full perimeter of the facility which would provide increased structural stability. This structural zone would include the final perimeter slope and a 33 ft (10 m) -wide crest around the perimeter. Tailings filter cake in the interior of the lined dry stack facility (non-structural zone) would be moderately compacted. A typical cross section of the lined dry stack facility is included as Figure 2-14. A typical cross section of the perimeter contact water ditch and groundwater cutoff wall associated with the lined dry stack facility is included as Figure 2-15. Contact and process water management for the lined dry stack facility is discussed in Section 2.13.5.

Two-dimensional stability analysis was conducted using a typical cross-section of the dry stack facility structure and foundation design. The analyses considered a number of scenarios including: construction (with elevated pore pressures), long term static, post liquefaction and pseudo-static seismic loading. The stability analyses were used to inform the design of the dry stack facility embankment geometry and foundation treatments and to confirm that the dry stack facility design meets required factors of safety for stability during operations and closure. The design of the 4H:1V exterior slopes and well-compacted tailings in the structural zone would provide long term stability around the perimeter of the dry stack facility. The design of the 6H:1V interior (temporary) slopes would provide a stable working surface for the dry stack facility within the non-structural interior. If any weak, compressible, or loose soils would be identified the foundation of the dry stack facility, these undesirable soils would be excavated and hauled to the reclamation material stockpile for use in closure.

As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be concurrently covered and reclaimed. The dry stack facility cover is anticipated to consist of a cover soil as a suitable growth medium, underlain by a hydraulic barrier. Reclamation of the dry stack facility is discussed in Appendix B.

In order to achieve geotechnical requirements, dry stack facility construction would not proceed during extremely wet periods (heavy rain or snowmelt) or during extremely cold periods as the tailings must be compacted prior to freezing.

2.5.6 Wash / Spray Station

The wash / spray station would be a concrete pad with a sump located south of the filter plant (Figure 2-7). The wash / spray station would be used to clean equipment prior to maintenance, transport, or storage.

2.5.7 Monitoring

Vibrating wire piezometers and slope inclinometers would be installed along the exterior slopes of the lined dry stack facility. These instruments would monitor pore pressure response and movement in the dry stack facility. If monitoring shows an unacceptable rise in pore pressure, then pore pressure would be allowed to dissipate before placement of additional material on the dry stack facility. Similarly, if the slopes of the dry stack facility show an unacceptable amount of movement, then remedial measures would be implemented to improve stability.

Specific protocols for monitoring of the lined dry stack facility would be carried out in accordance with a Project monitoring plan.

2.5.8 Reclamation Material Stockpile

During site preparation of the lined dry stack facility, suitable growth medium, which includes topsoil, peat, and mineral soil, would be stripped from the site and stockpiled for future reclamation activities.

Organic soil and mineral soil would be stored separately, but in the same stockpile area, designated as the tailings management site reclamation material stockpile (Figure 2-7). During reclamation, the organic soil and mineral soil would be blended or placed in layers, to a minimum thickness of two ft (0.6 m), depending on the reclamation cover soil design. Based on preliminary estimates of depth to bedrock and organic soil thickness, it is estimated that 502,000 yd^3 (384,000 m^3) of organic soil (topsoil and peat) and 878,000 yd^3 (671,000 m^3) of mineral soil would be stripped and stockpiled.

Construction of the dry stack facility infrastructure would be completed in three stages. As such, not all of the soil would be stripped during initial construction. In addition, because the dry stack facility would be concurrently reclaimed throughout the operational period of the mine, reclamation material would be regularly removed from the reclamation material stockpile. The maximum size of the reclamation material stockpile would be 871,000 yd^3 (666,000 m^3) in Year 16 and would be less than the total volume of stripped material. Tailings management site reclamation material stockpile dimensions are shown in Table 2-10.

2.5.9 Power Distribution

Power distribution to the tailings management site would be via overhead power lines from the plant site electrical substation. The power lines would follow the

service road connecting the plant site and tailings management site and would terminate at the E-house switch yard located adjacent to the filter plant (Figure 2-7). Power would be distributed from the E-house switch yard to facilities within the tailings management site including the filter plant, backfill plant, and the filter cake storage and loadout building.

Power would be distributed to contact water ponds as necessary to power the pumps. Power distribution would follow the service road around the dry stack facility perimeter to the various tailings management site contact water ponds.

2.6 Non-Contact Water Diversion Area

The non-contact water diversion area would consist of a system of dikes and diversions to divert non-contact water around the plant site and the tailings management site (Figure 2-2, Figure 2-5, and Figure 2-7). Water supply and management is discussed further in Section 2.12 and specifics are included in the Project's non-contact water management plan (Appendix C).

2.7 Access Road

The access road is depicted in Figure 2-2 and discussed in Section 2.2.2. The access road would be a two-lane, gravel road with 14 ft (4.3 m) -wide lanes for a total road width of 28 ft (8.6 m). The access road construction limits would be approximately 200 ft (61 m) wide, depending on corridor grading limits. Ditches would be provided for stormwater runoff control, and culverts would be sized to accommodate 100-year, 24-hour storm event.

2.8 Water Intake Corridor

The water intake corridor would extend from the plant site westward to Birch Lake reservoir and would terminate at the water intake facility. The water intake corridor would include a pipeline, buried power line, and a gravel single-lane access road. The typical layout of the water intake facility is included as Figure 2-16, and the water intake facility plan, profile, sections, and details are illustrated in Figure 2-17.

The water intake corridor construction limits would be approximately 100 ft (30.5 m) -wide depending on corridor grading limits. The water intake facility would be located a minimum of 100 ft (30.5 m) from the shore of Birch Lake reservoir. An intake pipeline would extend from the water intake facility into Birch Lake reservoir and a screened, low-flow intake (0.5 feet per second or less) would be located at the end of the intake pipeline, approximately 550 ft (170 m) away from the shore of Birch Lake reservoir. The intake pipeline (approximately 18 inches in diameter) would enter the water a minimum of 3 ft (1 m) below the water level, lay on the bottom of the lake, and would draw water from a depth of approximately 15 ft (4.6 m) at the end of the pipeline (Figure 2-17). From the low-flow intake, water would be pumped via the

water intake facility to the plant site where it would be used as make-up water for Project operations.

2.9 Transmission Corridor

The transmission corridor would include a two-track, unpaved maintenance road and the power transmission line which would originate from an off-site electrical substation and terminate at the plant site electrical substation, as illustrated on Figure 2-2. The transmission corridor construction limits would be approximately 150 ft (46 m) wide, depending on corridor grading limits. Transmission corridor maintenance width would be 150 ft (46 m) or less. Construction of the transmission corridor is provided in Section 2.16.5 and an illustrative cross section of the transmission corridor is included as Figure 2-9.

2.10 Production Schedule

The current mine plan utilizes 61% of ore reserves in federal mineral leases, 36% in state mineral leases, and 3% in private mineral leases over a 25-year operational mine life. Mineral leases and land ownership information for surface and mineral resources are included in Appendix A.

Over the currently proposed 25-year operational mine life, approximately 180 Mst (163 Mt) of ore would be extracted from the underground mine. Table 2-11 and Table 2-12 summarize the mine plan over the 25-year operational mine life by production and resource category, respectively. Figure 2-18 summarizes the mine plan by lease owner type. Due to the ore body shape, the underground mine was divided into five major mining production zones, as illustrated in Figure 2-19, Figure 2-20, and Figure 2-21. Initial development would focus on Zone 1. After achieving full production, the mining progression would continue toward Zone 2 through Zone 5. Figure 2-22 illustrates the mine plan over the 25 years of active mining by zone.

2.11 Staffing

The Project would operate 24 hours a day, 365 days a year. Shifts will comply with all lease and permitting terms and conditions. It is anticipated that mine and processing personnel would work two, 12-hour shifts on a four-day-on / four-day-off shift rotation schedule and processing supervisors would work on a 12.5-hour day to cross over with the next shift rotation. Management and administration staff would work weekdays, eight hours per day. Exceptions would exist for specific technical staff and operators, as necessary and determined by their job responsibility.

Table 2-13 presents the anticipated number of employees required for the Project. TMM anticipates that most workers would be hired locally, with incentives for relocation required only in the case of specialized expertise.

2.12 Rock Management

TMM would manage mined rock based on three rock categories:

- Ore: rock mined from the basal mineralized zone (BMZ) that contains the targeted metals – copper, nickel, cobalt, platinum, pallidum, gold, and silver – which would be recovered through the concentrator to three concentrates;
- Development rock: sulfide barren rock mined from the hanging wall that would be used for construction aggregate. Development rock would be mined during the construction of the declines and ventilation raises, and periodically throughout the project. Development rock would be used as construction aggregate to meet fill requirements; and
- Waste rock: rock mined during operations below the targeted cut-off grade that would be managed underground and placed in mined out stopes for permanent storage.

The material characterization program would further define the rock types and their suitable uses. Development rock would be tested to confirm its geochemical suitability for use as fill based on guidelines to be developed in the material characterization program. Section 5.3 discusses the current status of TMM's material characterization program summarizing key findings and presents a future work scope for the continued development and execution of the material characterization program.

During the construction phase, as the mine declines and ventilation raises approach the BMZ, mined rock would be monitored and tested to determine the cut-off point where sulfide mineralization begins. When sulfide mineralization begins, this would represent the "end" of the development rock. During the construction phase, rock with sulfide mineralization would be handled as ore. Ore mined during the construction phase would be temporarily stockpiled on surface in the pre-operational ore stockpile at the temporary rock storage facility. The temporary rock storage facility is described in Section 2.4.1. The pre-operational ore stockpile would be processed when the concentrator begins operating. No rock would be categorized as waste rock during the construction phase because there would be a lower ore cut-off grade during the construction phase than during the operation phase.

During the operation phase, ore would be crushed underground and transported by conveyor to the coarse ore stockpile. Rock mined during operations that is below the cut-off grade, would be treated as waste rock. This waste rock would be managed underground by placing the waste rock in mined out stopes prior to backfilling with engineered tailings backfill.

At no point in time throughout the construction or operation phases would waste rock be transported to the surface; rock transported to surface would either be classified

as ore (and processed through the concentrator) or development rock (and used as construction aggregate).

Through Project design and rock management strategy, acid rock drainage (ARD) potential from the two most common ARD sources associated with mines of this type (waste rock stockpiles and tailings) has been avoided. First, the Project would not have permanent waste rock stockpiles on the surface, due to the underground mining and processing strategy of ore, thus avoiding the potential for ARD from permanent waste rock stockpiles on surface. Second, the Project would recover most sulfides from the ore, producing a tailings with sulfur less than 0.2% S. Testwork on Duluth Complex tailings, including Maturi ore tailings from the Project's pilot plant, has demonstrated this level of sulfur to be non-acid generating. Geochemical characterization results are summarized in Section 5.3.

2.13 Water Supply and Management

TMM would manage water to avoid and minimize environmental impacts subject to appropriate federal and state agency oversight. Overall, water would be routed from the underground workings to the plant site, from the plant site to the tailings management site, then from the tailings management site back to the plant site. Birch Lake reservoir would supply make-up water for processing, as needed.

Key principles of the Project water management approach are as follows:

- The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water;
- Extensive water reuse would minimize the amount of make-up water needed from Birch Lake reservoir; and
- Stormwater and surface water from outside the site would be diverted, following natural drainage patterns to the extent possible, so it does not mix with water on the site.

Water would be managed in four categories:

- Process water – water that would be used in the process to grind the ore and recover the targeted metals;
- Contact water – water, in the form of direct precipitation or stormwater, that would potentially come in contact with ore or tailings, but has not been used in the process or combined with process water;
- Non-contact water – water that would not come in contact with ore or tailings; includes water from adjacent watersheds that would be diverted around the facility; and
- Construction stormwater: direct precipitation or stormwater that has contacted surfaces disturbed during construction, but that has not contacted ore.

TMM is continuing to evaluate appropriate management of other forms of industrial stormwater.

The water use strategy would set the following priority order for process water sources:

1. Reuse of process water;
2. Use of mine inflow;
3. Use of contact water; and
4. Make-up water from Birch Lake reservoir.

Water balance analysis indicates that the Project would be a net-consumer of water. Even with extensive water reuse, the Project would require make-up water to process the ore. The Project would have the following consumptive uses:

- Residual water would remain in the filtered tailings placed on the dry stack facility;
- Water would be consumed in the engineered tailings backfill;
- Residual water would remain in the filtered concentrates that are shipped to market; and
- Evaporation would occur from multiple sources across the Project.

The Project would capture water from the following sources and use it to meet process water demand:

- Mine inflow – the groundwater that would flow into the underground workings; and
- Precipitation – direct precipitation and stormwater that would be collected as contact water.

Water from mine inflow and precipitation would be variable and water that could not be used immediately in the process would be stored in ponds across the site to meet future water demand.

The Project's combined consumptive use would be greater than the combined water sources of mine inflow and precipitation. Therefore, to meet processing water demand the Project would intermittently withdraw make-up water from Birch Lake reservoir. Water from Birch Lake reservoir would be withdrawn on an as-needed basis when the process water demand could not be met by available mine inflow and contact water in storage. The average withdrawal from Birch Lake reservoir would be expected to fall within the range of 75 to 130 million gallons (gal) of water a year. To achieve the required withdrawal, the instantaneous rate of pumping would be approximately 800 gpm and would be stopped when other sources of water meet water demands. To put the withdrawal into context, 800 gpm is equivalent to approximately 30 garden hoses.

Specific water supply and management facilities and features are discussed in the following sections.

2.13.1 Mine Supply Water Storage

Supply water for the underground mine would flow from the mine water tank to the portals to feed the underground mine-wide supply water distribution system. The mine water tank would be supplied from the fresh/fire water tank and the sediment pond when available (Figure 2-5). The mine water tank would have a capacity equivalent to a four-hour supply of service water. Level sensors in the tank would be used to monitor and control the tank water level. The mine supply water system would not be connected to the underground fire suppression system, which is handled separately.

2.13.2 Contact Water Ponds

Three contact water ponds would be located within the plant site to manage stormwater as contact water which has contacted process components. These ponds include the:

- North contact water pond;
- South contact water pond; and
- Central contact water pond.

Five contact water ponds and two interim contact water ponds would be located within the tailings management site to manage surface water which has contacted process components. These ponds include:

- Tailings management site contact water pond 1;
- Tailings management site contact water pond 2;
- Tailings management site contact water pond 3;
- Tailings management site contact water pond 4;
- Tailings management site contact water pond 5;
- Interim tailings management site contact water pond; and
- Interim tailings management site contact water pond 2.

Contact water pond locations are illustrated in Figure 2-5 and Figure 2-7 for the plant site and tailings management site, respectively. The ponds would be sized to contain 100-year, 24-hour storm event. In addition, the collective storage capacity of the contact water ponds for the lined dry stack facility during operation would be sized to meet the stormwater runoff requirements from a 100-year snowpack. Each pond's catchment area and dimensions are provided in Table 2-14. The contact water ponds would be single lined with a 60 mil high density polyethylene (HDPE) or engineer-approved alternate geomembrane liner over a 1-foot (300 mm) thick, low-permeability, compacted soil layer. The soil layer would be compacted to meet maximum hydraulic conductivity requirements of not more than 1×10^{-6} centimeters

per second (cm/sec). A typical cross section of the contact water pond liner is illustrated in Figure 2-23. Major inflows for each pond would include inflows of catchment stormwater runoff and pond direct precipitation. Major outflows for each pond would include pond evaporation, pumping to another pond, or use in the process. Ultimately, these contact waters would be managed through the process and contact water management system, as discussed in Appendix D and Section 2.13.5.

2.13.3 Process Water Storage

The process water management strategy would be to prioritize water use for processing by the following list:

1. Reuse of process water;
2. Use of mine inflow (classified as process water as it would mix in the underground mine dewatering system);
3. Use of contact water; and
4. Make-up water from Birch Lake reservoir.

Process Water Pond

The process water pond would be the central collection and distribution point for water used during the processing of ore at the concentrator. Water recycled from the process, contact water ponds, underground dewatering, and makeup water supply from Birch Lake reservoir via the fresh/fire water tank would ultimately be collected in and distributed from the process water pond. The process water pond location is illustrated in Figure 2-5. The process water pond would be double lined with leak detection and would be designed for year-round operation. The liner system would consist of a 60 mil HDPE or engineer-approved alternate geomembrane liner underlain by a geocomposite drainage layer, a 40 mil HDPE or engineer-approved alternate geomembrane liner, and a 1-foot (30.5 cm) layer of compacted material. A typical cross section of the process water pond liner is illustrated in Figure 2-23.

The pond volume would be approximately 18,500,000 gal (70,000 m^3). The process water pond would be sized to contain direct precipitation from the 100-year, 24-hour storm event with appropriate freeboard.

Process Water Tank

The process water tank would act as surge control between the process water pond and the concentrator and would store approximately 264,000 gal (1,000 m^3) of water. Level sensors in the tank would be used to monitor and control the tank water level.

Process Area Fresh/Fire Water Tank

The fresh/fire water tank would hold approximately 264,000 gal (1,000 m^3) and would be located near the concentrator building. Level sensors in the tank would be used to

monitor and control the tank water level, as well as control the number of raw water supply pumps being used at any one time. The fresh/fire water tank would be supplied with water from Birch Lake reservoir via the water intake facility and water intake corridor.

Water from the fresh/fire water tank would be used in the process, as well as the underground mine-wide service water distribution system. A minimum volume of approximately 180,000 gal (680 m^3) of fire water would be maintained in the bottom section of the fresh/fire water tank. Fire water pumps would be located in the concentrator building. The volume of water which would be maintained for fire water is based on a sprinkler demand of 2,000 gallons per minute (gpm) (454 cubic meters per hour [m^3/hr]) for one hour and a hose demand of 500 gpm (114 m^3/hr) for two hours.

Process Area Potable Water

A modularized potable water treatment system would provide potable water to the mine services building, concentrator building, and concentrator services building. The water for this system would be sourced from the fresh/fire water tank. The location of the modular potable water supply system and tank is illustrated on Figure 2-5.

Sediment Pond

Underground mine water would be pumped from the underground workings, de-oiled on the surface using oil-water separators, and clarified in the sediment pond at the plant site. The sediment pond would have the same liner design as the contact water ponds and would overflow into the process water pond. The sediment pond location is illustrated on Figure 2-5.

The mine dewatering rate would be up to 53,000 gallons per hour (gal/hr) and variable over time. A portable slurry pump would be used to periodically sluice sediment from the sediment pond to the filter plant or other appropriate location. The sediment pond would have a volume of 1,268,000 gal (4,800 m^3) and would be sized to require clean-up less than once a year to coincide with concentrator maintenance. Depending on the characterization of the sediment, the sediment removed would either be placed on the dry stack facility or disposed of off-site appropriately.

2.13.4 Process Water

As discussed in Section 2.13.3, water recycled from the process circuit, contact water ponds, underground mine water, and makeup water supply from Birch Lake reservoir via the fresh/fire water tank would ultimately be collected in and distributed from the process water pond for use as production water. Process water would be used during the operational phase of the Project.

Additional make-up water would be drawn from Birch Lake reservoir via the water intake pipeline in order to maintain the process water pond at a target volume to provide sufficient surge capacity to balance make-up water requirements. Facilities associated with the water intake pipeline are discussed in Section 2.8, and illustrated on Figure 2-5.

2.13.5 Surface Water Management

The site non-contact water management plan is included as Appendix C and the site contact and process water management plan is included as Appendix D.

Contact and Process Water

Process Water Management

As discussed in Section 2.13.3, the process water pond would be the main supply of water to the concentrator and underground mine. Project water management would maximize reuse of water and the process water pond would be refilled by underground mine water pumped from the underground workings, contact water ponds, recycled process water, and make-up water from Birch Lake reservoir. Design specification for the process water pond are discussed in Section 2.13.3.

Due to the designed management and in accordance with 40 CFR § 440 the system is a closed loop and the Project would not require discharge of process or contact water.

Plant Site Contact Water Management

To prevent contact water from leaving the plant site to the surrounding environment, the plant site would be graded to collect contact water in the contact water ponds (Figure 2-5). Ultimately, contact water ponds within the plant site would be directed to the process water pond and managed through the process water management system, as discussed in Section 2.13.2. Details and dimensions of the contact water ponds within the plant site are included in Section 2.13.2.

Additional information regarding contact and process water management for the plant site is included in Appendix D.

Tailings Management Site Contact Water Management

The tailings dewatering plant area would be graded during Project construction so that stormwater and meltwater runoff would flow to the south and into tailings management site contact water pond 1.

Contact water runoff from the lined dry stack facility would be captured in contact water ditches installed around the perimeter toe of the dry stack facility. A typical cross section of the exterior slope of the dry stack facility showing the contact water

system is shown in Figure 2-15. The contact water ditches would also serve to collect potential draindown, defined as seepage from the tailings or stormwater which has infiltrated the tailings after placement.

Construction of the lined dry stack facility is discussed in Section 2.16.4. The design of the lined dry stack facility, specifically the above-liner drains and the blanket toe drain would be intended to capture draindown at the base of the dry stack facility, diverting draindown to the contact water ponds via the contact water ditches, and controlling the phreatic surface. The primary purpose of the under-liner drain would be to reduce potential underlying groundwater pressure exerting uplift on the geomembrane liner. A secondary purpose of the under-liner drain would be to function as an environmental protection measure to capture potential seepage through the liner for the dry stack facility. The under-liner drains would discharge to the perimeter contact water ditches and any discharge would be managed as contact water. Seepage through the membrane to the underdrain is expected to be insignificant due the design of the dry stack facility, QA/QC during construction, and documented performance of other dry stack facilities; however, the quantity and quality of seepage has not been calculated for the design will be addressed as a future scope of work. In addition to the liner, over-liner, and under-liner drains, the dry stack facility would include the construction of a groundwater cutoff wall to protect groundwater. The groundwater cutoff wall would include a compacted soil seepage cutoff trench through the overburden soil beneath the perimeter haul road, and construction of a grout curtain below the trench, installed if required through zones of fractured or weathered upper bedrock.

The over-liner and under-liner drains, the liner, the contact water ditches, the groundwater cutoff wall, and the outer haul road would be constructed concurrently with the dry stack facility stages. Stage 1 of the dry stack facility would require the construction of tailings management site contact water pond 1, tailings management site contact water pond 2, and the interim tailings management site contact water pond 1. Stage 2 would require the construction of tailings management site contact water pond 3 and interim tailings management site contact water pond 2. Stage 3 would require the construction of tailings management site contact water pond 4, and contact water pond 5. Contact water collected in the contact water ponds would either be pumped to the process water pond for use as process water, used as dust control on the temporarily exposed surfaces of the dry stack facility, or used for filter cloth wash as available.

Design of the contact water ponds at the tailings management site is discussed in Section 2.13.2.

Non-Contact Water

Plant Site Non-Contact Water Management

A portion of the plant site would be managed as a non-contact area to allow flexibility for water management during extreme storm events. The non-contact area at the

plant site would include, the security gatehouse, reclamation material stockpile 1 and 2, the plant site electrical substation, the ball storage bunker, the concentrator, the concentrator services building, the reagent storage building, and the areas surrounding and connecting these facilities that are not directly involved in transport of ore or tailings by truck. Based on the operational water needs for the process at the time of storm events, water from the non-contact area would be either diverted away from the plant site to minimize the amount of contact water collected from the plant site or collected by the contact water collection system.

Additional information regarding non-contact water management for the plant site is included in Appendix C.

Tailings Management Site Non-Contact Water Management

The tailings management site would manage the following five main non-contact areas:

- Tailings management site reclamation material stockpile;
- Undeveloped portions of the tailings management site prior to development of stage 2 and 3;
- Portion of the exposed dry stack facility liner prior to tailings placement;
- Portion of the tailings dewatering plant; and
- Reclaimed portion of the dry stack facility.

Non-contact water management within these areas would be accomplished through the use of infrastructure such as diversion dikes, sediment ponds, non-contact water ditches, and other water management infrastructure. A full description of the non-contact water management within these five areas of the tailings management site can be found in Appendix C.

2.14 Transportation and Conveyance

Transportation and conveyance is addressed in the Project's transportation plan located in Appendix E.

2.15 Waste Management

The Project would produce solid wastes, sanitary wastes, and some hazardous wastes. All wastes would be disposed of in accordance with federal, state, and local regulations. Tailings management is discussed in Section 2.5.

2.15.1 Solid Waste

Non-hazardous solid wastes generated at the Project would be collected in trash cans and dumpsters. Dumpster removal and disposal would be provided by a

licensed waste disposal contractor. Metal, glass, plastic, and paper would be recycled, as practicable.

2.15.2 Sanitary Waste Handling

Sewage and sanitary liquid wastes would be collected and disposed of off-site by a licensed, third-party contractor.

2.15.3 Hazardous Waste

Hazardous solid and liquid wastes would be collected and temporarily stored on-site prior to off-site shipment to storage and disposal facilities in accordance with Resource Conservation and Recovery Act (RCRA) regulations. Hazardous waste would be transported in U.S. Department of Transportation (DOT)-approved containers to permitted hazardous waste treatment, storage, and disposal facilities. In the event of a release of a hazardous material, hazardous solid wastes would be contained, mitigated, and reported in accordance with the site spill contingency plan, included in Appendix F. Prevention, containment, and cleanup measures in the spill contingency plan would minimize the potential for related impacts to soils, vegetation, wildlife, and water resources.

2.16 Construction Phase

2.16.1 Construction Schedule

The Project schedule is described in terms of quarters (Q) with: Q1 being January, February March; Q2 being April, May, June; Q3 being July, August, September; and Q4 being October, November and December. Construction years are referred to as Year -3 to Year -1. Construction would occur during a 2.5-year period, from quarter Q3 of Year -3 to Q4 of Year -1, as illustrated on the construction schedule in Figure 2-24. This period would include time for construction of surface facilities and initial underground infrastructure construction. The construction phase would end with the commissioning of the concentrator, commencement of underground mining operations, and concentrate production.

2.16.2 Construction Access

An existing USFS road would provide immediate access to begin site clearing and grubbing activities and portal construction at the plant site. Existing USFS and exploration roads over the underground mine would also serve as access to the ventilation raises during construction. Existing USFS and county roads would provide construction access to the transmission corridor (Figure 2-2).

2.16.3 Clearing and Grubbing

Prior to beginning construction activities, the Project area would be cleared and grubbed and topsoil and peat would be stripped from the areas and stockpiled for reclamation, as described in Section 2.4.7. During clearing and grubbing, saleable lumber would be harvested and sold by a licensed, USFS-approved third-party contractor. The remaining plant matter would be chipped and used to cover the reclamation material stockpiles to prevent wind and water erosion. Additional woodchips would be strategically placed in the laydown yards for future use during Project reclamation activities.

2.16.4 Dry Stack Facility

The dry stack facility would be developed in three stages from west to east. Development would begin during the construction phase and would continue through the 25 years of operation. Each stage would begin by constructing the dry stack facility infrastructure followed by tailings filter cake placement. Tailings filter cake placement would occur during operations as described in Section 2.5.5. The following discussion relates to the construction of the dry stack facility infrastructure which would include: a liner system (under-liner drains, geomembrane liner, over-liner drains), contact water ditch, groundwater cutoff wall, haul road, and associated contact water ponds.

Construction of the dry stack facility stage 1 infrastructure would occur from Q3 of Year -3 through Q4 of Year -1. For each stage of infrastructure construction, the dry stack facility site would be prepared by clearing and grubbing vegetation, draining standing water and preparing the subgrade, which would consist of removing sharp rocks and other debris and then proof-rolling the foundation subgrade soils. Where bedrock is exposed, it would be covered with a minimum six-inch thick (15 mm) bedding layer of compacted local borrow material. The footprint of each dry stack facility construction phase dry stack facility would include a prepared foundation with gravel under-liner drains, a 60 mil thick LLDPE or engineer-approved alternate geomembrane liner, and over-liner drains. The contact water ditch, groundwater cutoff wall, and haul road would be installed around each dry stack facility stage. An illustration of Stage 1 construction is included as Figure 2-25. An illustration showing surface reliefs of the original ground, and dry stack facility at the end of Stage 1, Stage 2, and Stage 3 (after placement and compaction of tailings) are included as Figure 2-26. Phased development and reclamation of the dry stack facility is discussed in Section 2.5.5. The phased construction of the contact water ponds is discussed in Section 2.13.5.

2.16.5 Transmission Corridor

The transmission corridor would include an overhead electric transmission line which would be constructed concurrently with other Project facilities, with the primary construction window expected to be from March through October, excluding river and wetland crossings, where winter is preferred to utilize frozen ground and dormant

wildlife and vegetation. TMM expects two work fronts: one starting at the plant site; and one starting at the off-site electrical substation identified on Figure 2-2. The transmission corridor construction limits would be approximately 150 ft (46 m) -wide. Transmission line structures would be placed in such a way as to avoid wetlands and sensitive habitats, as practicable. An illustrative cross section of the transmission corridor is included as Figure 2-9.

2.16.6 Water Intake Corridor

The water intake corridor would include a pipeline, power line, and a maintenance road with a water intake pump house near Birth Lake reservoir. These features be constructed concurrently with other Project facilities in the same manner as described for the transmission corridor with the following exceptions: construction from one front starting at the plant site, and the water intake corridor construction limits would be approximately 100 ft wide.

2.16.7 Plant Site Surface Infrastructure

The setup of temporary surface facilities would begin during excavation of the portal. The following list indicates the temporary facilities to be used during construction, as illustrated on Figure 2-27:

- Portal pond;
- Heater;
- Gensets;
- Exhaust fans at the portal;
- Temporary surface crushing facility;
- temporary rock storage facility;
- Transfer station and feed hopper;
- Temporary equipment parking;
- Tramp metal / debris stockpile;
- Cold storage warehouse;
- Truck wash;
- Shops;
- Water tank;
- Wash facility septic tank;
- Office;
- Mine dry;
- Mine rescue room;
- Light vehicle parking;
- Fuel day tank; and
- Blasting magazines.

2.16.8 Portal and Mine Decline Development

Portal and decline development would occur from Q4 of Year -3 through Q4 of Year -2. The portals would be excavated using drill and blast in two benches. To minimize overbreak on the excavation walls, presplitting methods would be used. After the portal excavations are completed, loose rock would be scaled and bolted to ensure safe access. The portals would then be constructed of corrugated steel on parallel concrete curb foundations. The entire box cut would be backfilled with engineered fill which would come from on-site or off-site sources.

The decline would then be keyed in for a minimum distance of 50 ft (15 m).

During construction, the two declines would be the primary ventilation source for the underground mine until the first vent raise is constructed and commissioned.

2.16.9 Underground Mine Development

Primary objectives of underground mine construction would include the development of ramps and haulage areas, and development of access to the first ore production areas. Secondary underground mine construction objectives would include the excavation of drifts for backfill and ventilation, establishment of the ventilation circuit and dewatering systems, and development of satellite workshops, fueling stations, and explosives magazines.

The ventilation raises would be constructed by raise bore technique. The raise bore technique utilizes a raise bore drill that drills a pilot hole from surface. The pilot hole would intersect the targeted drift underground and then a reamer would be attached to the drill shaft. The reamer would be sized to the final diameter of the ventilation raise. The drill would then pull the reamer from the underground drift to surface. The drilled rock would be removed from the bottom of the ventilation raise and handled by underground equipment. When the ventilation raise is drilled during the construction phase, the rock would be handled as development rock and thus transported to surface for use as construction aggregate.

2.16.10 Ore Stockpiling - Temporary Rock Storage Facility

As discussed in Section 2.4.1, ore produced during construction would be temporarily stored in the lined temporary rock storage facility until the concentrator is constructed and commissioned.

2.16.11 Development Rock and Construction Materials

Construction of the plant site platforms would advance as development rock is generated during excavation of the declines. Major foundations would be on excavated bedrock, and platforms for construction access and laydown would be developed as excess development rock becomes available.

Although crushed development rock from the mine declines is likely to be suitable for structural backfill, road surfacing, and concrete aggregate after crushing and blending, a third-party contractor would transport granular materials needed for drains, structural backfill, concrete aggregate, and bedding layers to the Project area, as necessary.

2.16.12 Concentrator and Tailings Dewatering Plant

Construction of the concentrator and tailings dewatering plant, which includes the tailings thickener, filter plant, tailings filter cake storage and loadout building, and the backfill plant, would begin in Q3 of Year -3 and would be complete by Q3 of Year -1. Concentrator and tailings dewatering plant construction would begin with the procurement, fabrication, and delivery of major equipment.

2.16.13 Equipment

Construction equipment would generally include the surface mobile equipment identified for Project operations in Section 2.4.7, as well as the primary and secondary underground mining equipment identified in Section 2.3.7. Other equipment which would be required for clearing and grubbing, as well as general civil earthworks would include:

- Bulldozers;
- Scissor lifts;
- Cranes;
- Compactors;
- Liner handling machines;
- Excavators; and
- Additional drills.

2.16.14 Electrical Equipment and Materials

Electrical power during the construction period is expected to be provided by on-site diesel generators (gensets). During construction, these gensets would be located northeast of the portal area. Grid power would be delivered to the site by the start of equipment commissioning and continue through operations and into closure.

2.16.15 Construction Stormwater Management

Construction activities would be conducted in accordance with the Minnesota Construction Stormwater General Permit, following best management practices (BMPs) in an agency approved Storm Water Pollution Prevention Plan (SWPPP). Contact water generated during construction would be discharged, as required, in compliance with permits.

2.16.16 Construction Labor

In total, approximately three million labor-hours would be required to construct the Project. Fluctuations in the total hours would likely occur due to the seasonal nature of constructing the lined dry stack facility or other bulk earthwork projects.

2.16.17 Temporary Housing Needs

Temporary housing (i.e. temporary trailer parks or man camps) would not be required.

2.17 Site Operations Security and Safety

2.17.1 Security

As discussed in Section 2.4.7, a staffed security gatehouse would control primary access to the site. The location of the gatehouse is shown on Figure 2-5.

2.17.2 Employee Health and Safety

TMM holds the safety and health of team members, contractors, suppliers, and neighboring communities as a core organizational value. As such, TMM would require compliance with applicable health and safety regulations, TMMs safety and health management system, and the TMM safety policy.

During operations, training for new employees would include TMM specific training in addition to required MSHA training as outlined in 30 CFR § 48 subparts A and B. Training for the operation of specific equipment would also be required. To support this need, mining equipment manufacturers would train future operators in the specifics of new equipment as part of the equipment purchase contract and TMM, with the help of mining equipment manufacturers, would develop specific training plans as described in 30 CFR § 48.3 and 48.23. Similarly, process operator training would be augmented with simulators and shadowing of experienced operators.

TMM is a participating member of the National Mining Association's CORESafety initiative, which serves as a framework to ensure compliance with the regulatory requirements of the Occupational Safety and Health Administration (OSHA) and the eventual transition to the MSHA requirements applicable to TMM's future operations. TMM also utilizes the International Council on Mining and Metals Critical Control Management Implementation Guide to ensure alignment with internal safety and health requirements.

Health and safety standards or procedures to be applied at the Project are described in the OSHA 1910 General Industry Standards (OSHA, 2019a), OSHA 1926 Construction Standards (OSHA, 2019b), applicable U.S. Federal Metal and Nonmetallic Mine Safety and Health Standards in 30 CFR for Surface and

Underground Mines (USDL, 2019) from MSHA, and relevant state and local statutes and regulations.

TMM Safety Policy

The TMM Safety Policy would apply to Project team members throughout the Project's construction, operation, and closure phases, including contractors, suppliers, and visitors. The TMM Safety Policy would be communicated to team members by appropriate TMM personnel on an ongoing basis.

TMM's Safety Policy has been developed using the following strategies:

- Assessing potential health hazards and safety risks as early as possible;
- Preventing or effectively controlling potential safety risks beginning with the Project's design and continuing through mine closure and post-closure;
- Investigating health and safety incidents and implementing action plans to prevent recurrence;
- Allocating sufficient time, money, and focus to operate safely; and
- Communicating about health and safety performance openly and honestly.

2.17.3 Safety Evaluation

TMM would maintain an internal risk register for the Project based on the severity and likelihood of potential risks and consequences. The results from risk assessments would be included in the risk register.

If Project-related industrial hygiene risks are identified, TMM would consult with an industrial hygiene specialist to determine exposure limits and controls or corrective measures to eliminate or minimize exposure risk.

Safety Support Systems

The underground mine would rely on three safety support systems: a centralized blasting system, a production equipment dispatch system, and a general personnel and equipment asset tracking system. The combination of the three safety support systems would allow for efficient and safe operation.

Centralized Blasting System

The centralized blasting system would work in conjunction with the proposed digital leaky feeder system to provide full, two-way blast control for underground applications. This system would allow blasting to be initiated a safe distance from the blasting site (e.g. from the surface for the blasting of stopes). The centralized blasting system would rely on remote and master devices, the latter allowing control over multiple remote devices at a time.

Equipment Dispatch

An equipment dispatch system would allow for the efficient and timely assignment of resources to tasks in the mine. The system would enable dispatch for main production equipment of the mine including jumbos, bolters and production drills, powder trucks, LHDs, shotcrete sprayers, transmixers, and production trucks.

Asset Tracking System

For safety purposes, the asset tracking system would provide the identification and location of personnel and assets throughout the Project. Specifically, check-points would be located underground to acquire the position of personnel and equipment. While the system would not be meant to track exact locations, the reference to checkpoints would be sufficient in the event of an emergency.

2.17.4 Fire and Emergency Planning

Steady-State Operation

Evacuation plans would be developed for structures including the mine services building, concentrator, filter plant, backfill plant, filter cake storage and loadout building, process services building, and the underground mine, as well as other structures that might require evacuation during an emergency. These plans would outline the procedures that should be followed in the event of fire or other emergency requiring evacuation and would define responsibilities of key personnel. Evacuation maps that show suggested evacuation locations and emergency response routes would be posted at strategic locations throughout the site.

During production, there would be three exits from the underground mine. The access decline would be the primary escape route and the conveyor decline would be the secondary escape route for mine personnel. A third exit would be through one of the ventilation raise shafts. An elevator would be installed to support emergency evacuations in this location.

As specified in in Section 2.3.7, refuge chambers would provide a safe atmosphere for up to 36 hours in the event of an emergency. MSHA requires that refuge chambers be located so that mine personnel can reach them within 30 minutes from their work area. The refuge chambers would be portable and would be relocated accordingly as mining progresses. Additionally, mine rescue teams would be available as per 30 CFR § 49 Subpart A,

Emergency Communications and Stench Warning System

Radio would be the primary means of communication during an emergency. Mine equipment would be radio-equipped. Radios would also be installed at first-aid stations and refuge chambers.

A stench gas warning system would be used as a secondary emergency warning method. In the event of an emergency, stench gas would be injected into the ventilation raises. The stench gas system would be activated automatically as part of evacuation procedures, or from the central control room or central dispatch.

2.18 Exploration

No surface exploration programs are planned to occur within the Project area during Project operations. If exploration becomes necessary in the future, TMM would pursue exploration permitting activities separately from this MPO.

2.19 Off-Site Ancillary Facilities

2.19.1 Administrative Buildings in Ely and Babbitt

Administration buildings would be located off-site in Ely and Babbitt, Minnesota. Busses would transport the majority of hourly personnel from the administration buildings to the Project as described in the transportation plan (Appendix E).

3.0 ENVIRONMENTAL SETTING

3.1 Land Use and Zoning

3.1.1 Existing Land Use

The Project area would be in both Lake and St. Louis counties on a mix of uplands and forested wetlands within the Superior National Forest (SNF). The landscape surrounding the Project area is primarily characterized by undeveloped, forested uplands and wetlands to the north, east, and south, with Birch Lake reservoir located to the west. A portion of the Project area includes School Trust Land within the Bear Island State Forest. School Trust Lands are state-owned lands which are set aside to provide a continual source of funding for public education. Revenue from School Trust Lands is generated from sale and lease of the lands and minerals, and resource extraction through timber sales and mineral royalties. Within the vicinity of the Project area (approximately 10 miles [16 km]) examples of land use include:

- Subsistence hunting, fishing, and gathering;
- Gravel pits;
- A hydroelectric plant;
- Dimension stone mining operations;
- State, county, and forest road networks;
- High voltage transmission lines;
- An airport;
- Historic and current mining features such as pit lakes and stockpiles;
- Commercial timber harvest;

- Silviculture;
- Agriculture;
- Residential (cities of Babbitt and Ely, Minnesota);
- Fire management; and
- Recreation.

The land within the Project area is managed for multiple uses, including mineral resource development. Mineral development in the region is discussed in Section 2.1.

In addition to commercial and industrial uses, the region is a destination for recreation. The Project lies within the Bear Island State Forest boundary and is approximately five miles from the southwestern border of the Boundary Waters Canoe Area Wilderness (BWCAW) at the nearest point. Additionally, the Project is outside of the state minerals management corridor adjacent to the BWCAW (Figure 3-1). The law that created the BWCAW also designated the BWCAW as a Mining Protection Area, which prohibits exploration, lease, and exploitation of minerals in the wilderness. It further extends the prohibition of mineral exploration or exploitation on property owned by the United States if that activity could materially change the wilderness characteristics of the BWCAW.

Recreational land uses typically occurring within the Project area or within 25 miles (40.2 km) of the Project area may include, but are not limited to:

- Boating, canoeing, and camping in the BWCAW and other local, state, and federal lands;
- Hunting and fishing;
- Year-round recreation, including downhill skiing, snowmobiling, off-highway vehicle (OHV) use, mountain biking, hiking, golf; and
- Recreational trails.

Recreation opportunities in the SNF are managed within the framework of the Recreation Opportunity Spectrum (USFS, 2004). The Project lies within a designated Roaded Natural area. This designation indicates areas where motor vehicles have full access with limited-moderate remoteness, interactions with other users may be frequent, and where human activity such as timber harvesting may be visible.

The Project area also falls within the boundaries of territory governed by the 1854 Treaty between the Chippewa of Lake Superior and the United States (Figure 3-2). The 1854 Treaty ceded all of the Lake Superior Chippewa lands in the Arrowhead Region of Northeastern Minnesota to the United States, in exchange for reservations for the Lake Superior Chippewa in Wisconsin, Michigan, and Minnesota.

The rights to capture or gather (or take) subsistence resources within the 1854 Ceded Territory are provided to the Bands on a usufruct basis. The concept of individuals not owning specific land, but using the resources on land controlled by

larger cultural groups, represented this usufruct basis that was so important to the survival of the Ojibwe everywhere in Minnesota prior to European settlement.

As a usufructuary created by the 1854 Treaty, the Bands are allowed to use resources from land owned by others. Rights for hunting and fishing under the 1854 Treaty are exercised on lands within this territory.

The Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Fond du Lac Band of Lake Superior Chippewa (the Bands) are located within the 1854 Ceded Territory. These land uses may occur in the Project area; however, the extent of use by Band members has not been documented at this time.

There are no prime or unique farmlands, agricultural preserves, or conservation lands in the Project area.

3.1.2 Planned Land Use

There are six land use management plans which geographically overlap with the Project area;

- Lake County Comprehensive Plan and Land Use Ordinance (Lake County, 2017);
- Lake County Local Water Management Plan (Lake County, 2012);
- St. Louis County Comprehensive Land Use Plan (St. Louis County, 2019);
- St. Louis County Comprehensive Water Management Plan (St. Louis County, 2010);
- City of Babbitt Comprehensive Plan (Arrowhead Regional Development Commission [ARDC] Regional Planning Division, 2014); and
- Land and Resource Management Plan for the SNF (USFS, 2004); and
- Northern Superior Uplands Section Forest Resource Management Plan (MDNR, 2015 Draft).

While comprehensive plans are not regulatory decision standards, these plans do provide a vision for land management within each respective location and have been developed through collaboration between the primary governing body (Lake County, St. Louis County, Babbitt, or USFS), other applicable governmental bodies, local constituents, and other interested parties. The comprehensive plans do provide a framework for decisions reflected in other regulatory contexts, such as zoning ordinances and forest management. A comprehensive map of local zoning and management areas can be found on Figure 3-3. Figure 3-4 show private parcels of land within Lake and St. Louis counties subject to local land or water management plans. Additionally, this figure identifies the nearest residences, which are associated with the South Kawishi Association (SKA) located to the north and west of the Project. These residences are the nearest sensitive receptors to the Project. Figure 3-5 shows federal parcels of land subject to the Land and Resource Management Plan for the SNF.

Lake County Comprehensive Plan and Land Use Ordinance

Private parcels of land associated with the plant site, water intake corridor, ventilation raise site 1, and portions of the transmission corridor within Lake County would be subject to the Lake County Comprehensive Plan and Land Use Ordinance. The primary purpose of the plan is to provide a vision statement for Lake County and to "promote the health, safety, and general welfare of the Lake County community." The plan identifies goals under various subject topics (i.e., housing, transportation, recreation, etc.) that act as a guide for achieving the vision the document lays out.

Lake County, Minnesota, Local Water Management Plan

Private parcels of land associated with the plant site, water intake corridor, ventilation raise site 1, and portions of the transmission corridor within Lake County would be subject to Lake County's Local Water Management Plan. The plan was created to "maintain and improve both surface and groundwater quality and quantity through sound ecosystem management" (Lake County, 2012). The Lake County Water Management Plan has been approved for an extension until 2019.

St. Louis County Comprehensive Land Use Plan

Private parcels of land associated with the transmission corridor and located in St. Louis County would be subject to the St. Louis County Comprehensive Land Use Plan (St. Louis County, 2019). The county's land use plan "provides a blueprint for managing growth, development, conservation, and other land use objectives in St. Louis County". The plan is sectioned into six areas of focus; natural environment, economic development, recreation and tourism, transportation, public safety, and land use. Goals, objectives, and implementation plans are then developed for each area of focus. The implementation plans are then ranked and tracked to provide a long-term vision for managing land use within St. Louis County.

Chapter 2 of the St. Louis County Comprehensive Land Use Plan provides insight into the county's land use goals with respect to economic development. The chapter specifically addresses mining and defines mining impact areas within the county in a three-tier system with the Project area located within a Tier 2 area. Tier 2 includes areas of more active non-ferrous exploration and mineral lease activity in the Duluth Complex. It encompasses the general co-location of exploratory borings, active mineral leases, and known mineral prospects.

St. Louis County Comprehensive Water Management Plan

Private parcels of land associated with the transmission corridor and located in St. Louis County would be subject to the St. Louis County Comprehensive Water

Management Plan. The county's water management plan "provides strategy to address the water-related issues in St. Louis County."

City of Babbitt Comprehensive Plan

Several private parcels of land associated with the transmission corridor and off-site electrical substation would be subject to the City of Babbitt Comprehensive Plan. This plan is intended to, "set policies for efficient land use and allocate land among industry, commerce, residences, public facilities, parks and recreation spaces, open and natural spaces, and other public and private uses." One of the specific goals outlined in the plan is to support non-ferrous mining projects in and around Babbitt.

Superior National Forest Land and Resource Management Plan

Portions of the plant site, tailings management site, ventilation access roads, access road, and transmission corridor located on federally owned land would be subject to the Superior National Forest Land and Resource Management Plan for the SNF. The purpose of the plan is to "guide all natural resource management activities for the Superior National Forest". The plan provides direction, goals, and implementation guidance intended to influence day-to-day management and long-term management of the SNF.

Northern Superior Uplands Section Forest Resource Management Plan

The Project would be located within the Bear Island State Forest, which is managed by the MDNR. Previously, this area was managed as three separate sections: Border Lakes, North Shore Area, and a portion of North 4. Currently, the forestry management plan for this area is being revised to consolidate these three areas into one area known as the Northern Superior Uplands. The Northern Superior Uplands Section Forest Resource Management Plan is in the process of being drafted with an anticipated completion date of 2019 according to information available on the MDNR website. The state forest management units within the Project area would be subject to the Northern Superior Uplands Section Forest Resource Management Plan.

3.1.3 Current Zoning and Management Codes

There are four zoning authorities associated with the Project area; City of Babbitt, Lake County, St. Louis County, and MDNR. Local zoning controls apply to the portions of the Project area within private ownership. Federal and state lands are not subject to local zoning controls but are governed by federal and state rules and regulations. A comprehensive map of local zoning districts applicable to the Project area are illustrated on Figure 3-3. This figure also identifies the Shoreland Zoning areas surrounding water basins (Birch Lake reservoir) and water courses (Keeley Creek, Denley Creek, and Stony River) within the Project area subject to additional shoreland zoning requirements. Figure 3-4 identifies parcels of land within the Project area subject to local zoning (Lake County, St. Louis County, Babbitt).

In addition to the zoning authorities, there are two primary 1854 Treaty area management entities:

1854 Treaty Authority

The 1854 Treaty Authority is an Inter-tribal Natural Resources Management Organization that manages the off-reservation hunting, fishing, and gathering rights of the Grand Portage and Bois Forte Bands of Lake Superior Chippewa in the territory under legal agreement with the State of Minnesota. The 1854 Treaty Authority's mission statement is to "provide an Inter-Tribal natural resource program to ensure that the rights secured to member Native American tribes by treaties of the United States to hunt, fish, and gather within the 1854 Ceded Territory shall be protected, preserved and enhanced for the benefit of present and future member Native American tribes in a manner consistent with the character of such rights, through provisions of services." The 1854 Treaty Authority's management of natural resources generally focuses on some of the most commonly hunted, fished, or gathered natural resources.

The 1854 Treaty Authority has adopted the Ceded Territory Conservation Code (2018). The Ordinance governs the Ceded Territory's "hunting, fishing, trapping and gathering activities of resources for subsistence use," subject to the provisions of this ordinance by Band Members within the Ceded Territory. The purpose of the Ordinance is:

- to provide an orderly system for 1854 Treaty Authority control and regulation of hunting, fishing, trapping and gathering of resources for subsistence use in the Ceded Territory; and,
- to provide a means to promote public health and safety; and the conservation and management of fish, wildlife and plant populations in the Ceded Territory through the regulation of Band Member harvesting activities.

Fond du Lac Band of Lake Superior Chippewa

Governance of hunting, fishing, trapping, management, and gathering of natural resources by the Fond du Lac Band of Lake Superior Chippewa within the 1854 Ceded Territory is demonstrated in the Fond du Lac Ceded Territory Conservation Code. The purpose of the Code is to provide a system for tribal control and regulation of hunting, fishing, and gathering within the Ceded Territory, provide a means to promote public health and safety through the conservation and management of natural resources within the Ceded Territory, and to promote and protect the rights of the Fond du Lac retained under the 1854 Treaty.

The Fond du Lac Band of Lake Superior Chippewa has adopted a Ceded Territory Conservation Code (as amended). The purpose of the Code is to provide:

- An orderly system for tribal control and regulation of hunting, fishing, gathering, trapping and resources management in the 1854 ceded territory;
- A means to promote public health and safety and the conservation and management of fish, wildlife, natural resources and plant populations in the Ceded Territory through the regulation of Band Member harvesting activities; and
- To the fullest extent possible, to promote and protect the rights of the Fond du Lac Band of Lake Superior Chippewa retained under the 1854 Treaty.

3.2 Geology, Soils, and Topography / Land Forms

The Project area is underlain by the geologic group referred to as the Duluth Complex which is composed of magmatic (igneous) rocks associated with the Midcontinent Rift System. The Midcontinent Rift System occurred approximately 1.1 billion years ago and is traceable from the east side of Michigan, arcing west across the Lake Superior basin, and extending south-southwest to northeastern Kansas. The thinning of the earth's crust (rifting) that resulted from tectonic extension allowed for large layered igneous intrusions and vulcanism. The largest composite of these layered intrusions is the Duluth complex, a composite intrusion of igneous rocks (troctolites to gabbros and anorthosites) derived from episodic intrusive events from an evolving magma source related to rift development. The Duluth Complex is the host of the Maturi mineral deposit shown on Figure 3-6. To the north and west of the Project area, rocks of the Superior Province of the Canadian Shield include Archaean (greater than [>] 2,600 million years old) mafic to felsic metavolcanic rocks, metasedimentary rocks, ortho- and paragneisses, and granitic intrusions; and to the southwest, Paleoproterozoic (around 1,850 million years old) iron-formation, clastic, and carbonate metasedimentary rocks of the Animikie Basin.

3.2.1 Bedrock

The Project area would be located at the contact of two major bedrock units, the Giants Range Batholith (GRB) and the Duluth Complex.

The Duluth Complex is composed of mafic to felsic tholeiitic magmas related to the Midcontinent Rift System and makes up much of the bedrock of northeast Minnesota. It is bounded by a footwall of Paleoproterozoic sedimentary rocks and Archean granite-greenstone terranes and a hanging wall largely of rift-related flood basalts and hypabyssal intrusions of the Beaver Bay Complex (Miller et al., 2002).

The targeted mineralization of the Maturi deposit is hosted within the basal portion of the South Kawishiwi Intrusion (SKI), known as the BMZ. The SKI is bordered on the southwest by the Partridge River Intrusion, on the northwest by the GRB and Biwabik Iron Formation, the Anorthositic Series to the northeast, and on the southeast by the Bald Eagle Intrusion. Excluding the transmission corridor, lithologic units within the Project area include Mesoproterozoic rocks of the SKI and the Anorthositic Series of the Duluth Complex, as well as basalt xenoliths of the North Shore Volcanic Group.

SKI magmas intruded sub-horizontally between hanging wall Anorthositic Series rocks and footwall granitic rocks of the GRB. Additionally, the transmission corridor portion of the Project area includes the lithologic units of the Biwabik Iron Formation and the Giants Range Granite. A brief description of the map units associated with the Project are discussed in the generalized stratigraphy of the Maturi deposit shown on Figure 3-7. A bedrock geology map of the Project area is shown on Figure 3-8 and cross sections of the deposit are shown on Figures 3-9 through 3-12.

As shown in the cross sections and discussed in the geologic description, the Project area does not include shallow limestone formations and the bedrock conditions associated with the Project are not susceptible to geologic conditions such as sinkholes or karst conditions.

3.2.2 Surficial Geology

Surficial geology in the Project area is dominated by glacial deposits associated with the Rainy Lobe that include areas of peat and lake sediment. In some localities along the shoreline of Birch Lake reservoir, the Rainy Lobe Till has been eroded by water, resulting in a less rugged surface expression and a possible surface lag consisting of concentrated coarse-grained clasts. The lake sediment is predominantly silt, clay, and organic material (Jennings and Reynolds, 2005). The thickness of surficial material in the Rainy Lake Watershed is generally less than (<) 50 ft (15.6 m) and is laterally discontinuous. In the vicinity of the plant site, bedrock crops out in five to 20% of the area (Ericson et al., 1976).

3.2.3 Mineralogy

The deposit is composed of anorthositic troctolite to troctolites. The mineralogy consists primarily of plagioclase, olivine, pyroxenes, and oxides which make up more than 85% of the total mineralogy. The alteration minerals (e.g., serpentine, chlorite, etc.) typically comprise 1% to 6% of the mineralogy but are locally found in amounts up to 15%. Sulfide content of the ore-bearing geologic units ranges from 1% to 6%, with very local areas having sulfide contents outside of that range.

The main four sulfides present in the deposit include:

- Chalcopyrite;
- Cubanite;
- Pentlandite; and
- Pyrrhotite.

Other copper and nickel sulfides are present in the deposit but occur in minor amounts (<5% total sulfides).

3.2.4 Structure

Rock units and mineralization in the BMZ are planar and sub-parallel to the lower contact with an average strike of approximately 60 degrees (°) and dips of 20° to 52° to the southeast. The vertical thickness of the potentially mineable grades varies in width from 49 to over 591 ft (15 to 180 m), averaging from 197 to 328 ft (60 to 100 m). The depth of the potentially mineable grades ranges between 984 to 3,005 ft (300 to 916 m) amsl.

The Maturi deposit has not been significantly deformed, but it has been subjected to minor displacements along reactivated basement faults, as well as cross faults. Mapped structures are mostly sub-vertical north–northeasterly striking faults.

3.2.5 Soils and Topography / Landforms

The Project area is within the Nashwauk Uplands (212Lc) and Border Lakes (212La) subsections of the Northern Superior Uplands (NSU) Section within the Laurentian Mixed Forest (LMF) Province (MDNR, 2019a). Wetlands commonly occur in the numerous depressions and potholes. The upland vegetation typically consists of fire-dependent forests and woodlands. Generally, the terrain within the Project area is flat to gently sloping with localized areas of small, steep ascents. From the low topographic point on the shoreline of Birch Lake reservoir, the topography gradually increases moving inland and culminates just east of the Project area. Within a mile of the Project area, topographic relief varies as much as 200 ft (61 m). Project area topography is shown on Figure 3-13.

Natural Resources Conservation Service Soil Data Survey

The Natural Resources Conservation Service (NRCS) maintains a public inventory of soil survey data for Minnesota. This inventory contains a variety of information on soil map unit distribution, physical and chemical characteristics, and information on soil usability for purposes such as structural foundations, septic fields, and other uses.

The NRCS soil survey data are complete for the entire Project area and there are no gaps in the mapping or the attribute data. NRCS soil survey data identified within the Project area are displayed on Figure 3-14. Map unit descriptions, physical soil properties, hydric soil, soil engineering properties, including information on corrosion susceptibility and frost heave potential are described in Table 3-1. The most abundant NRCS soil map units within the Project area include: Eveleth-Conic-Aquepts (I2b21D), Greenwood soils (J1a40A), Rollins-Cloquet (F25D), and Babbitt-Aquepts, (I2b19A).

Sensitive soils for this area include both hydric soils (which are susceptible to rutting in non-frozen conditions) and thin soils over shallow bedrock (which are susceptible to erosion when disturbed). Sensitive hydric soil units have at least 50% abundance of hydric components and include the following map units: Rifle soils (1021A), Greenwood soils (1022A), Aquepts-Tacoosh-Rifle (I3-11A), Cathro muck (J2-40A),

and Bowstring / Fluvaquents soils (K2-10A). According to the NRCS data, predominantly hydric soils account for approximately 27% of the NRCS data within the Project area.

Sensitive shallow soils have bedrock within 60 inches (1.5 m) of the ground surface and include the following map units: Eaglesnest-Wahlsten (F2B), Eveleth-Conic (F4E), Eveleth-Eaglesnest-Conic (F3D), and Eveleth-Conic-Aquepts (F35D). According to the NRCS data, soils with depths to bedrock of <60 inches (1.52 m) account for <10% of the NRCS data within the Project area.

Ecological Land Types Data

The USFS maintains a public inventory of Ecological Land Types (ELT), which includes natural community information on geologic landforms, soils, and associated botanical assemblages within the SNF. These data are part of a hierarchy of landscape information that is intended to guide decision-making, inform environmental analyses, and direct the management and monitoring of natural resources on public lands. As defined in the Land and Resource Management Plan for the SNF (USFS, 2004), an ELT is:

"an ecological map unit which is a subdivision of landtype associations or groupings of landtype phases that are areas of land with a distinct combination of natural, physical, chemical and biological properties that cause it to respond in a predictable and relatively uniform manner to the application of given management practices. In a relatively undisturbed state and / or a given stage of plant succession, an ELT is usually occupied by a predictable and relatively uniform plant community."

The USFS ELT data are complete for the portion of the Project within Lake County. ELTs identified by the USFS within the Project area include those displayed on Figure 3-15. ELT 1 and 5 are considered to have sensitive soils because of susceptibility to rutting and compaction. ELT 18 is considered to have sensitive soils because of susceptibility to erosion. Attributes of each ELT are described in Table 3-2.

Monitor Well Data

In addition to the NRCS and ELT data, the thickness of unconsolidated sediments was recorded during the installation of monitor wells in and around the underground mine area. Monitor well records indicate most unconsolidated deposits range from 0 to 20 ft (0 to 6 m) thick near the underground mine area.

3.3 Paleontological Resources

The underground mine, plant site, and the tailings management site lie within an area comprised of magmatic (igneous) rocks, and rocks within the Project area which

pre-date complex life forms. As such, paleontological resources are not anticipated to occur within or around the Project area.

3.4 Water Resources

This section summarizes baseline conditions for surface water, groundwater, and wetlands in the vicinity of the Project area. For each of these water resources, this section identifies resources in the vicinity of the Project area and summarizes the baseline characteristics of the resource.

3.4.1 Surface Water

Watersheds and Waterbodies in the Vicinity of the Project Area

The Project area would be located north of the Laurentian Divide with water flowing north towards Hudson Bay. The U.S. Geological Survey (USGS) defines this at a broad scale as the Rainy Headwaters (Hydrological Unit Code-8 [HUC-8] Subbasin [HUC 09030001]). The same area is defined by MDNR as the Rainy River Headwaters Major Surface Water Watershed. USGS HUC boundaries are shown on Figure 3-16 and MDNR watershed boundaries are shown on Figure 3-17.

At a finer watershed scale, the Project area is within the USGS Birch Lake and Stony River watersheds (HUC10) and Birch Lake, South Kawishiwi River, Denley Creek, and Outlet Stony River sub-watersheds (HUC12). The Project area is within the MDNR South Kawishiwi River, Filson Creek, Keeley Creek, Denley Creek, Stony River, and Unknown minor watersheds shown on Figure 3-16. Table 3-3 shows the area of Project features within the HUC12 and MDNR watersheds.

Birch Lake reservoir is the largest water body in the vicinity of the Project area. It was originally a complex of river beds before the 1890s when it was impounded for log transport (Reavie, 2013) by a dam at its northern end where it feeds into White Iron Lake reservoir through the South Kawishiwi River. Birch Lake reservoir has a maximum depth of 25 ft (7.6 m) and the water level can drop by as much as four ft (1.2 m) in winter according to water management needs of the Winton Hydroelectric Station located on the South Kawishiwi River between Garden Lake reservoir and Fall Lake.

Public waters basins and watercourses within the vicinity of the Project area are listed in Tables 3-4 and 3-5.

Hydrology

The general hydrologic regime in the vicinity of the Project consists of a relatively thin, discontinuous, layer of quaternary unconsolidated materials overlying relatively impermeable bedrock. Precipitation runs off into surface water bodies or recharges groundwater in the quaternary unconsolidated materials. Groundwater from the

quaternary unconsolidated materials primarily discharges to streams, lakes, reservoirs, and wetlands in the area.

Generally, stream flow follows a seasonal pattern, with peak flows in the spring and low flow in the winter. Magnitude of flow varies widely with stream size with the highest flows measured in the South Kawishiwi River and the lowest flows in Filson Creek and Keeley Creek.

A stream morphology assessment has been conducted for the site. Stream types were classified under the Rosgen classification system as either Type E or C.

Type E streams are typically stable streams and are not in the process of a channel evolution. They typically have low width-depth ratios (<12); are slightly entrenched (entrenchment ratio >2.2), and high sinuosity (> 1.5). The riparian vegetation is often dominated by grasses and shrubs.

Type C streams are also typically stable streams not in the process of channel evolution. They typically have moderate to high width-depth ratios (>12); are slightly entrenched (entrenchment ratio >2.2), and moderate to high sinuosity (>1.2). Type C streams often have point bars on the inside bank of a meander and a relatively low stream slope. The vegetation is often dominated by woody trees and shrubs.

Birch Lake Reservoir Water Level

Birch Lake reservoir water level is at an elevation of roughly 1,414 ft (431 m) amsl. The water level on Birch Lake reservoir is controlled by a dam operated by Minnesota Power at the northern most end of the lake where it drains into White Iron Lake reservoir through the South Kawishiwi River. Water levels are controlled based on water management needs of the Winton Hydroelectric Station at the north end of Garden Lake reservoir. Dam operation results in a winter drawdown of about 4 ft.

The *MDNR LakeFinder* (MDNR, 2019b) data identifies Birch Lake reservoir as having a recorded water level range of 5.7 ft (1.7 m).

Surface Water Quality

This section provides an overview of regional surface water quality and identifies impaired waters in the Project vicinity.

Regional Surface Water Quality

The Project would be located in a region composed of forests, marshes, and wetlands. Surface water quality is generally considered good, with dilute cation / anion concentrations and broadly characterized as a calcium-bicarbonate type water with generally low turbidity, low total suspended solids, and neutral pH (7.2 to 8.3) (MPCA, 2017).

Generally, the data demonstrate stream water quality at the South Kawishiwi River is weakly buffered, with dilute cations / anions, exhibiting fairly low specific conductance ranging between 19 to 50 microSiemens per centimeter (µS/cm), and alkalinity between 120 and 320 milliequivalents per liter (meq/L). Like many rivers in the region, the South Kawishiwi River is tea-colored due to high tannins, or incompletely dissolved organic materials. Water type is calcium-magnesium-bicarbonate type, likely due to the influence of geology and weathering of primary minerals, including calcium-rich plagioclase and pyroxene minerals (Mast and Turk, 1999).

Streams in the vicinity of the Project area contain soft water with low alkalinity, low total dissolved solids (TDS), low nutrients, high color, very low trace metals concentrations and low fecal coliform counts (EQB, 1979). Relative to other streams, nutrient concentrations (i.e., phosphorous and nitrogen) are low. Concentrations of copper, nickel, and zinc are very low within the region (generally one to two microgram per liter [µg/L]). Other trace metals of biological importance, including arsenic, cadmium, cobalt, mercury, and lead have median concentrations significantly below one µg/L (EQB, 1979).

In lakes, the overall concentrations of nutrients (phosphorous and nitrogen) is relatively low, though median values were higher south of the Laurentian Divide than north of it. The most productive lakes within the region are shallow headwater lakes, surrounded by extensive bog and marsh areas (EQB, 1979). Because lakes have a large surface area of bottom sediments and longer residence times, the chemistry of outflow water can differ from the inflow water with respect to trace metals concentrations. Large lakes, such as Birch Lake reservoir, also exhibit variability in concentration of metals.

While surface water quality is generally good (MPCA, 2017), the lakes in the region have been subject to human-induced environmental changes since European settlement of the region approximately 140 years ago (Reavie, 2013). Work to reconstruct past environmental conditions in the White Iron Chain of Lakes has shown anecdotal and measured evidence that indicates “several stressors are having detrimental impacts, or have the potential for negative effects, on the quality of this system” (Reavie, 2013). This is a result of treated and untreated domestic wastewater, and agricultural and urban runoff. Another historical human-induced water quality stressor in the area is erosion. This was a result of much of the watershed being deforested in the late 1800s through the early 1900s and is still an issue today with development of residential property and recreational motor boating (Reavie, 2013).

Impaired Waters

There are two Minnesota Pollution Control Agency (MPCA) 303d Impaired Waters within one mile of the Project:

- Birch Lake reservoir for aquatic consumption-mercury in fish tissue; and
- Keeley Creek for aquatic life-fishes' bioassessments.

3.4.2 Groundwater

This section identifies the hydrogeologic units in the vicinity of the Project area, summarizes baseline hydrogeologic characteristics and groundwater quality, and identifies groundwater use in the vicinity of the Project area.

Hydrogeologic Units in the Vicinity of the Project Area

Hydrogeologic units (HGUs) are groupings of geologic materials that have similar hydrogeologic properties and offer a degree of continuity across a project or regional area. Using field methods and associated interpretations of data the following HGUs have been defined for the Project area:

- Quaternary Unconsolidated Materials (QUM) – The QUM includes soil, alluvial deposits, peat, and glacial deposits from ground surface to the top of bedrock, generally a thickness of 0 (where bedrock occurs as an outcrop) to 50 ft (15.2 m);
- Shallow Bedrock - Shallow bedrock is Duluth complex and GRB rock with low permeability, from the top of bedrock to a depth of approximately 300 ft (91.4 m) below the top of bedrock. Shallow bedrock is differentiated from deep bedrock by higher relative fracture density. In areas near the BMZ outcrop, the BMZ can be considered shallow bedrock; and
- Deep Bedrock – Deep bedrock is Duluth complex and GRB rock with very low permeability (lower relative fracture density) that extends from approximately 300 ft (91.4 m) below the top of bedrock to the top of the GRB. Deep bedrock includes the BMZ in down dip locations.

A conceptualization of the defined HGUs is shown on Figure 3-18.

Groundwater Quality

This section provides an overview of regional groundwater quality.

Regional Groundwater Quality

Groundwater quality in Northern Minnesota varies locally with geology and with depth, but can be generalized broadly as hard water, with elevated concentrations of iron and / or manganese (Cotter et al, 1965; Maclay, 1966). Siegel and Ericson (1980) reported groundwater chemistry from within the Project area and observed significant differences related directly to the geology of the aquifer. For example, the reported mean and median concentrations of major ions, specific conductivity, and hardness in water from till hydrostratigraphic units was twice that found in water from sand and gravel aquifers. The source of some of this variation may be related to the

surface area to volume ratios between the till and sand / gravel aquifers and retention / contact times due to differences in hydraulic conductivity.

The observed pH of water from sand and gravel aquifers ranged from 5.8 to 7.1 while the pH of water from Rainy Lobe till ranged from 6.2 to 8.0. This difference likely reflects rapid recharge to the sand and gravel aquifers from precipitation, and a shorter time available for equilibration and chemical reactions with aquifer material (Siegel and Ericson, 1980).

Samples from sand and gravel aquifers, and also from peat, are mixed calcium-magnesium bicarbonate type groundwater, which is typical of groundwater in contact with calcic igneous minerals. Water sampled from wells in till are calcium-magnesium-bicarbonate or calcium-magnesium-sulfate type, with the latter being collected in the vicinity of the Project area (Siegel and Ericson, 1980). Concentrations of trace metals such as copper, cobalt, and nickel are generally low (<30 µg/L) but can exceed 100 µg/L in surficial material directly over the mineralized contact zone between the Duluth Complex and older rocks. Siegel and Ericson (1980) attribute these concentrations to the oxidation of sulfide ores at the contact zone. Less variation is observed in chromium, cadmium, and lead. Iron concentrations vary strongly and may reflect local redox conditions.

Groundwater quality in the deeper wells is difficult to characterize from historical data but can be characterized as sodium-chloride to sodium-bicarbonate type. The occurrence of localized brackish water has been reported by the Superior National Forest. Siegel and Ericson (1980) sampled six wells in the Duluth Complex, and observed high level of variability. For example, chloride concentrations ranged three orders of magnitude, from 1.3 to 1500 mg/L. Some data suggests concentrations may increase with depth, but it is likely that groundwater quality composition is a function of local hydrogeochemical conditions because water in the Duluth Complex occurs in isolated fractures and joints. The pH of water at depth was generally neutral to basic ranging from 7.0 to 8.5.

MPCA (GWMAP, 1999) reports that groundwater quality is generally good in the region, and generally controlled by geology. Precambrian aquifers in the region have groundwater quality comparable to similar aquifers statewide. Concentrations of major cations and anions are generally lower in Quaternary hydrostratigraphic units relative to deeper units statewide, though concentrations of trace metals can be higher. Trace inorganic parameters that may be of concern locally include beryllium, boron, manganese, arsenic, and selenium. In general, the Quaternary aquifers tend to be calcium-magnesium-bicarbonate type waters, while localized deeper water can be sodium chloride type.

Groundwater Use

The Minnesota Department of Health (MDH) establishes well head protection zones which serve to limit activities which could impact public water supplies. The Project would be located outside of any establish well head protection zone with the closest

wellhead protection area located in Babbitt about 10 miles (16 km) from the plant site as shown on Figure 3-19. Twenty-five private and public water wells are located within 1 mile (1.6 km) of the underground mine, plant, and tailings management site areas as identified in the Minnesota Well Index (MWI). Wells registered with in the MWI are shown on Figure 3-20.

3.4.3 Wetlands

This section describes the available data sources and characterizes the wetlands in the Project area using two different classification systems:

- The simplified plant community classification system – The Minnesota update of the National Wetlands Inventory (NWI) uses a classification system that is based on the Eggers and Reed (2015) system. In the NWI data, the Eggers and Reed (2015) classification system was simplified from the 15 original classes to nine vegetated classes and one non-vegetated aquatic class (Macleod et al., 2016). This simplification was done because of the difficulty of assessing distinctions between these plant community classes at a remote sensing scale. This classification system was used to describe the wetlands in the Project area because the Eggers and Reed system is commonly used to quantify potential wetland impacts and set wetland replacement goals: and
- The Circular 39 classification system - The Circular 39 system was developed by the USFWS in 1956 and broadly divides the wetlands in Minnesota into eight types. This classification system was used to describe wetlands in the Project area because it is required for an environmental assessment worksheet by Environmental Quality Board guidance.

Data Sources

The Minnesota update of the NWI was used to establish a baseline of wetlands in the Project area. This is a public geographic information system database based on the framework of the NWI and was created for use for wetland regulation and management, land use and conservation planning, environmental impact assessment, and natural resource inventories (Macleod et al., 2016). The update uses the same wetland definition as was used for the original NWI (adapted from Cowardin et al., [1979]):

- “Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season each year.”

Simplified Plant Community Classification System

Baseline acreages of wetlands in the Project area, calculated using the simplified plant community classification system, are listed in Table 3-6, and shown on Figure 3-21. In the NWI data, the Eggers and Reed (2015) classification system was simplified from the 15 original classes to nine vegetated classes and one non-vegetated aquatic class (Macleod et al., 2016). This simplification was done because of the difficulty to assess distinctions between these plant community classes at a remote sensing scale. This Eggers and Reed classification system was used to estimate the wetlands in the Project area because it is the Eggers and Reed system is commonly used regarding quantifying potential wetland impact and setting wetland replacement goals.

The most common wetlands within the Project area by this classification system are Coniferous Bog, Open Bog, and Shrub Wetland. These wetland types are also the most common wetlands in the Rainy River - Headwaters watershed. The Minnesota update to the NWI calculated summary statistics of wetlands for the whole Rainy River – Headwaters watershed and showed that the main wetland types by the simplified plant community classification system are Non-Vegetated Aquatic Community (37.9%), Coniferous Bog (32.8%), Shrub Wetland (8.5%), and Open Bog (8.1%) (Kloiber et al., 2019). Descriptions of each wetland type can be found in the report *Wetland Plants and Plant Communities of Minnesota and Wisconsin* (Eggers and Reed, 2015).

Circular 39 Classification System

Baseline acreages of wetlands in the Project area, calculated using the Circular 39 classification system, are listed in Table 3-7, and shown on Figure 3-22. Acreages in the Project area were estimated using this system as its simplicity is an asset for remote sensing and desktop mapping. Similar to the simplified plant classification system, the Circular 39 wetland classifications show that the most common wetlands within the Project area are also the most common in the Rainy River - Headwaters watershed.

The most common wetlands within the Project area by this classification system are Type 8 Bogs, Type 6 Shrub Swamp, and Type 3 Shallow Marsh. The Minnesota update to the NWI calculated summary statistics of wetlands for the whole Rainy River – Headwaters watershed and showed that the main wetland types by the Circular 39 system are Type 8 Bogs (40.9%), Type 5 Shallow Open Water (38.6%), Type 6 Shrub Swamp (8.6%), and Type 3 Shallow Marsh (5.0%) (Kloiber et al., 2019). Descriptions of the Circular 39 wetland types can be found in the report *Wetlands of the United States - Their Extent and Their Value to Waterfowl and Other Wildlife* (Shaw and Fredine, 1971).

3.5 Hazardous, Toxic, and Radiological Waste

A review of the *What's In My Neighborhood* (MPCA, 2019) web mapping tool was conducted to identify potential areas of concern within or proximal (within 0.5 mile [0.8 km]) to the Project area. Areas of concern identified, but not limited to, hazardous waste generators, solid waste facilities, remediation sites, leak sites, and locations with aboveground storage tanks. The review indicated there are no known areas of concern within the Project area; however, there are two potential areas of concern adjacent to the Project area identified as Sites 12 and 13 within Dunka Mine Area 8. Both locations are petroleum remediation leak sites associated with former LTV Steel mining activity located near the southwest end of the transmission corridor and the off-site substation. The MPCA identifies these sites as inactive and provided closure letters for both locations in 1998. No actions connected to the Project are anticipated to disturb these locations.

3.6 Terrestrial and Aquatic Resources

Terrestrial and aquatic resource baseline conditions were examined within the Project area using multiple sources. The specific resources summarized in this section include land cover, habitat, ecosystems, fish, wildlife, and vegetation including sensitive species.

3.6.1 Terrestrial Resources

The Project area is within the boundaries of the SNF and the Bear Island State Forest. Generally, the Project area is categorized as upland coniferous forest dominated by pine, fir, aspen, and spruce. Wet cover types within the Project area include lowland conifer swamps, poor fens, and bogs.

Human activities have influenced the characteristics of the existing terrestrial resources. Historically, much of the area was deforested in the late 1800s through the early 1900s (Reavie, 2013). Logging in the 19th century was followed by widespread slash-fueled wildfires in the 20th century. More recently fire suppression and vegetation management activities have determined the present forest makeup. Like most natural systems, the effects of disturbances on the landscape shape the habitats seen today.

The Project area is crossed by a system of unpaved roads that allow access for ongoing timber harvest, silvicultural activities, fire management, recreational access, and mineral exploration. On the northwestern edge of the Project area permanent residential structures have been constructed on the shore of Birch Lake reservoir.

The Project area has a history of mineral exploration and mining, as described in Section 2.1. Currently, Kasota Stone operates a stone quarry on state of Minnesota School Trust Lands located within the footprint of the tailings management site. Logging has also taken place on the School Trust Lands.

Terrestrial Habitat

In order to characterize the baseline habitat conditions for terrestrial species, existing land cover and habitats were identified based on the MDNR/USFS Ecological Classification System, the USGS Gap Analysis data, and the USGS National Land Cover Database.

MDNR / USFS Ecological Classification System

The Project would be located almost entirely within the Ecological Classification System's Border Lakes subsection of the NSU section of the LMF Province, as shown on Figure 3-23. There is a small portion at the southern end of the Project area that is within the Nashwauk Uplands subsection.

The LMF is characterized by broad areas of conifer forest; mixed hardwood and conifer forests; and conifer bogs and swamps. The NSU section largely coincides with the extent of the Canadian Shield in Minnesota and consists mostly of fire-dependent forests and woodlands. At the Border Lakes subsection scale, the major forest communities are characterized as jack pine forest, white pine-red pine forest, and hardwood-conifer forest. The Nashwauk Uplands subsection is dominated by quaking aspen forests (MDNR, 2019c).

USGS Gap Analysis Project / LANDFIRE National Terrestrial Ecosystems Data

The Project area is also defined by the USGS GAP / LANDFIRE land cover types as predominantly upland coniferous as shown on Figure 3-24 (USGS, 2011a). The Project area consists of:

- Boreal White Spruce-Fir-Hardwood Forest (42%);
- Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen (42%); and
- Boreal Jack Pine-Black Spruce Forest (8%).

The USGS GAP / LANDFIRE land cover types by Project components is provided in Table 3-8.

USGS National Land Cover Database

The National Land Cover Database data characterizes the Project area consists of:

- Woody Wetlands (39%);
- Evergreen Forest (32%);
- Mixed Forest (9%); and
- Shrub / Scrub Shrubland (8%) with minor amounts of other land covers including Grassland / Herbaceous and Deciduous Forest.

The National Land Cover Database land cover types are shown on Figure 3-25 and are broken down by Project components in Table 3-9.

These different classifications are defined in the *GAP / LANDFIRE National Terrestrial Ecosystems 2011* (USGS, 2011b).

MDNR Minnesota Biological Survey

The classification of baseline terrestrial resources within the Project area also considered the presence of native plant communities.

The MDNR MBS systematically collects, interprets, monitors, and delivers data on plant and animal distribution as well as the ecology of native plant communities and functional landscapes. Native plant communities are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes. For this review the MDNR Native Plant Community (NPC) database was used to identify whether native plant communities were present in the Project area.

Within the Project area, the NPC data becomes less complete in coverage further down the hierarchy. At the ecological system level, the majority of the Project area has data available, and the ecological systems identified are shown on Figure 3-26. Approximately 650 acres (263 ha) of the southwestern extent of the transmission corridor are unmapped (MDNR, 2019d). Within the Project area, the majority (93%) of the mapped ecological systems are acid peatland systems, fire-dependent forest / woodland systems, and a mesic forest complex, as shown in Table 3-10. Overall, upland communities cover approximately 70% of the Project area with wetland community types at 30% of the Project area.

Vegetation

Sensitive Species

There are 65 sensitive terrestrial vegetative species potentially present in the Project area (one fungus, 14 lichen, four moss, and 46 vascular plants) as summarized in Table 3-11. The species' federal and state statuses, Regional Forester Sensitive Species (RFSS) status, Species in Greatest Conservation Need (SGCN) status, recorded occurrences within the Project area in the Minnesota Natural Heritage Information System (NHIS) data, and listed habitats are also provided in Table 3-11. Descriptions for each of the species within the Project area are available from the MDNR Rare Species Guide (MDNR, 2019e).

The approximate locations of documented occurrences of sensitive vegetative and terrestrial species occurrences have been documented as shown on Figure 3-27.

Non-native Invasive Plants

There are 98 instances of non-native invasive plants potentially present in the Project. These include 16 instances of bull thistle (*Cirsium vulgare*), 33 instances of Canada thistle (*Cirsium arvense*), one instance of common St. Johnswort (*Hypericum perforatum*), 43 instances of common tansy (*Tanacetum vulgare*), and five instances of spotted knapweed (*Centaurea biebersteinii*).

The Minnesota Department of Agriculture (MDA) maintains a list of *State Prohibited* Noxious *Weeds*, with two categories; eradicate and control (MDA, 2019). Three species included on the MDA control list are also identified as present within the Project area (Canada thistle, common tansy, and spotted knapweed). There were no species identified in the Project area listed on the eradicate list.

Terrestrial Wildlife

Sensitive Species

There are 20 sensitive terrestrial wildlife species potentially present in the Project area (four insects, one spider, one reptile, six birds, and eight mammals). Potential sensitive terrestrial species within the Project area are identified in Table 3-12. The table also includes species' federal and state listing status, RFSS status, SGCN status, SNF indicator species status, recorded occurrences within the Project area in the NHIS data, and listed habitats. Descriptions for each of the species within the Project area are not included but available from the MDNR Rare Species Guide (MDNR, 2019e).

3.6.2 Aquatic Resources

Aquatic Habitat

The Project area contains three different aquatic habitats: Small Rivers and Streams, Littoral Zone of Lake, and Deep Water Zone of Lake. Lowlands and wetlands are considered as part of and included in the terrestrial habitats.

Aquatic Biota

Fisheries survey data

The MPCA has conducted fisheries surveys on several streams and rivers in the Project area.

Birch Lake Reservoir

Birch Lake reservoir is one of the most heavily used lakes in the MDNR's Tower Fisheries Management area. The MDNR has posted periodic fisheries survey data on the Birch Lake reservoir from 1981 through 2015. Fish species reported by the

MDNR for Birch Lake reservoir include black crappie, bluegill, burbot, cisco species, largemouth bass, northern pike, rock bass, smallmouth bass, tullibee, walleye, yellow perch, white sucker, bluntnose minnow, common shiner, emerald shiner, golden shiner, Johnny darter, logperch, spottail shiner, and trout-perch.

The non-native invasive species rusty crayfish are noted in the MDNR's Lake Finder summary for Birch Lake reservoir, with surveys through 2012 showing the rusty crayfish to be limited to the east end of the lake. The rusty crayfish is of concern for disrupting ecosystems, in part due to its larger appetite compared to native species of crayfish.

Keeley Creek

Keeley Creek is located just south of the tailings management site. In 2014, MPCA conducted a biological assessment of the creek at station ID 14RN006. MPCA documented the following fish species in the 2014 assessment: blacknose dace, brook stickleback, central mudminnow, common shiner, creek chub, finescale dace, genus notropis, Iowa darter, logperch, northern redbelly dace, pearl dace, and white sucker. Data on invertebrates was not collected. The assessment indicated that the fish rating was good with an Index of Biotic Integrity (IBI) of 88. The assessment also recorded August water temperature at 80.8°F (27.1°C) and dissolved oxygen levels of 7.07 mg/L (MPCA, 2014a).

Stony River

Stony River was sampled by the MPCA in 2014 upstream of where the transmission corridor would cross at station ID 14RN007. Aquatic biota sampling conducted in Stony River documented the presence of eight fish species and dominated by burbot. The assessment indicated that the fish and invertebrate rating was good, with an IBI of 87 and 72 respectively. The 2014 assessment also recorded August water temperature at 69.6°F (20.9°C) and dissolved oxygen levels of 9.89 mg/L (MPCA, 2014b).

Denley Creek

Denley Creek is a tributary to Stony River and is part of the Upper Stony River Watershed (MPCA, 2017). Denley Creek was sampled 0.5 mile upstream of where the transmission corridor would cross by the MPCA in 2014 at station ID 14RN067. Aquatic biota sampling conducted in Denley Creek documented the presence of 11 fish species and dominated by northern redbelly dace (MPCA, 2014c). In addition, MPCA documented a diverse invertebrate community. The upstream portions of Denley Creek are designated as cold-water resources. Brook trout have been documented in upper portions of Denley Creek and associated tributaries. MPCA has concluded that Denley Creek fully supports the aquatic life use and that the fish and invertebrate rating was good, with an IBI of 75 and 83 respectively. The 2014

assessment also recorded August water temperature at 64.4°F (18.5°C) and dissolved oxygen levels of 5.59 mg/L.

Unnamed Creek

Unnamed Creek is located east of the Dunka Pit and is a tributary to Birch Lake reservoir. In 1998, MPCA conducted a biological assessment of the creek at station ID 98RN001. During that assessment, MPCA documented the following fish species: blacknose dace, brook stickleback, creek chub, finescale dace, northern redbelly dace, and pearl dace. Data on invertebrates was not collected. The assessment indicated that the fish rating was good, with an IBI of 64. The 1998 assessment also recorded July water temperature at 65.1°F (18.4°C) and dissolved oxygen levels of 6.9 mg / L (MPCA, 1998).

Sensitive Species

There are 16 aquatic sensitive species potentially present in the Project area (two birds, six fish, six insects, one mussel, one reptile and 16 vascular plants). Potential sensitive aquatic species within the Project area are identified in Table 3-13. The table also includes species' federal and state status, RFSS status, SGCN status, recorded occurrences within the Project area in the NHIS data, and listed habitats. Descriptions for each of the species within the Project area are not included but available from the MDNR Rare Species Guide (MDNR, 2019e).

Wild Rice

Wild rice has been a culturally significant resource and a valuable food source for Native Americans for centuries. Wild rice is also recognized as an important food source for both migrating and resident wildlife. Birch Lake reservoir has been identified by the 1854 Treaty Authority and the MDNR as a wild rice water with potential to produce harvestable quantities of rice (MDNR, 2008). No other surface waters in the Project area are listed as wild rice waters by the MDNR.TMM has monitored wild rice in Birch Lake reservoir and other in the vicinity of the Project area since 2009.

Wild rice as a cultural resource is discussed in Section 3.7.3.

3.7 Historic Properties and Cultural Resources

In order to assess baseline historic, archaeological, and cultural resources, a review of archaeological surveys previously conducted within the Project area was completed. The results of this review inform ongoing Project planning and aid in compliance with state or federal cultural resources law, as applicable. The review used USFS files for the SNF and survey data on file at State Historic Preservation Office (SHPO) and Office of the State Archaeologist (OSA) as the primary sources of information. Table 3-14 provides a list of previous intensive archaeological reports

within the Project area. The field investigations associated with these reports are summarized as follows:

- The Duluth Archaeology Center conducted a Phase I archaeological survey along TH 1 in 2003. No archaeological resources were identified within the Project area;
- In 2011, 10,000 Lakes Archaeology, Inc. conducted a Phase I for potential Project components in Lake and St. Louis Counties. No archaeological resources were identified;
- A Phase I archaeological survey for hydrogeologic field activities was conducted in 2012. No archaeological resources were identified;
- A Phase I survey of a portion of the Project area was completed in 2012. One new archaeological site and three potential cultural resources (PR) were documented. Of the three, PR #2 and PR #3 are identified as being located within the Project area;
- A Phase I survey was completed for proposed hydrogeologic and exploratory drilling activities in 2013. No archaeological resources were identified;
- In 2016, a Phase I survey associated with a potential access road route was completed. No archaeological resources were identified;
- In 2017, portions of the Project area received a Phase IA visual assessment and Phase IB shovel testing. No archaeological resources were identified; and
- A Phase I survey of proposed hydrogeological well locations was completed in 2018, a portion of which were in the Project area. One previously identified archaeological site was encountered.

3.7.1 Archaeological Sites

Within the Project area, two archaeological sites have been previously identified. One of these sites, 21LA0568, has been field confirmed and the other, 05-006, has been reported, but not field confirmed.

Site 21LA0568 was recorded by SNF archaeologists in 1981. The site is characterized by metallic debris, cast iron stove parts, a bedspring, and a slag rock pile. Site 21LA0568 has not been evaluated for eligibility for listing in the National Register of Historic Places (NRHP). This location falls within the Project area.

Site 05-006 is an unconfirmed location of a settler's cabin. The existence and precise location of this site have not been field-verified. This site has not been evaluated for eligibility for listing in the NRHP. This location falls within the Project area.

3.7.2 Historic Properties

In addition to the two previously identified archaeological sites, two architectural properties have been previously inventoried within the Project area:

Erie Mining Company Mining Landscape Historic District and a building listed as LA-FLK-005.

The Erie Mining Company Mining Landscape Historic District (XX-DST-004) has been previously determined to be eligible for listing in the NRHP. The boundary for this district is not clearly defined and additional survey work not associated with the Project is being completed to more clearly define the boundary and contributing properties. Preliminary information identifies that the potential boundaries of the district, and at least one contributing property (Dunka Road, SL-ROD-004), overlap with a portion of the Project area.

LA-FLK-005 is a building within the Project area that has been previously inventoried but has not been evaluated for listing in the NRHP.

3.7.3 Cultural Resources

Two potential cultural resources have been identified within the Project area during previous survey work or work associated with other projects. These two potential cultural resources have not been formally recorded as archaeological sites or historical properties by SHPO, OSA, or SNF. These sites are identified as PR #2 and PR #3. In addition to these sites, the Mesabe Widjiu is potentially in the vicinity of the Project area but the exact geographic extent is not known.

PR #2 is identified as a pictograph of a geometric form in red pigment located on a large glacial erratic; this site was identified in 2013. Site visits with the Bois Forte Band of Chippewa elders indicate that this resource may have potential significance to Native Americans.

PR #3 is a semicircular stone arrangement associated with a rectangular depression; this site was identified in 2013. The origin and function, or potential significance to Native Americans, are unknown. Shovel tests excavated around the feature were negative, and no charcoal was observed.

Mesabe Widjiu, or the Laurentian Divide, is of cultural importance to Ojibwe tribes. This natural feature is a line of Precambrian hills that separates watersheds flowing north to the Arctic Ocean from those flowing south to the Great Lakes. The exact geographic extent of the Mesabe Widjiu and its proximity to the Project area are unknown.

The Chippewa people have a special cultural and spiritual tie to natural wild rice. Their migration story describes how they undertook a westward migration from eastern North America, which tribal prophets had foretold would continue until the Chippewa people found "the food that grows on water" (Benton-Banai, 1988). That food was wild rice, known as "manoomin," and it is revered to this day by the Chippewa as a special gift from the Creator. Natural wild rice remains a mainstay of traditional foods for the Chippewa community and offers significant nutritional value. The traditional practice of hand harvesting natural wild rice continues among both

tribal and non-tribal cultures. As discussed in Section 3.6.2, the Project is located within the area that was ceded to the U.S. by Chippewa bands in 1854 and portions of the Project area associated with Birch Lake reservoir have been identified as a potential wild rice resource.

3.8 Socioeconomics and Environmental Justice of the Local Community

A memorandum addressing current socioeconomic data, the *Twin Metals Minnesota - Socioeconomic Preliminary Baseline Demographic Data Collection*, was prepared for TMM by Short Elliott Hendrickson, Inc. (SEH) (SEH, 2018). A review of the current socioeconomic data was conducted for the Arrowhead region of northeastern Minnesota including Lake and St. Louis counties. Data sources include the 2010 U.S. Census (via the Bureau's American FactFinder), 2012 to 2016 American Community Survey data, Lake County and St. Louis County websites (including County Land Management Department webpages and Comprehensive Plans), Arrowhead Regional Development Commission plans, and the Northland Connection website.

Environmental Justice (EJ) refers to meeting the needs of underserved communities by reducing disparate environmental burdens, removing barriers to participation in decision making, and increasing access to environmental benefits that help make all communities safe, vibrant, and healthy places to live and work. In 1994, Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations* set forth the responsibility of Federal agencies to "make achieving environmental justice part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands."

According to Federal Highway Administration direction on conducting EJ analysis, a minority community is generally defined as one where the minority population in a study area (census tract or block group) is: either 10% higher than the county average; greater than 50% of the total geographic unit; or determined based on input from local officials or stakeholders. Determining the presence of low-income persons, groups, or clusters (e.g., living in geographic proximity) requires a review of the best available household income data and average household size compared to the U.S. Department of Health & Human Services (HHS) Poverty Guidelines. If the median household income of a "population" (census block, block group, or track) is determined to be below the HHS poverty guidelines, further investigations (field reviews, interviews, etc.) are needed to determine if an EJ population exists.

The presence or absence of EJ populations is addressed in the preliminary baseline data memorandum *Twin Metals Minnesota - Socioeconomic Preliminary Baseline Demographic Data Collection* (SEH, 2018).

3.9 Visual Resources

Within the Project area, the viewshed from the ground is predominantly tree cover with open areas created by timber harvest and dimension stone mining activities. Viewshed openings within a half mile of the plant site or tailings management site occur along the forest road network, from commercial logging activities, or around and on Birch Lake reservoir. Birch Lake reservoir is characterized by a viewshed similar to those commonly found on lakes in northern Minnesota of forested shoreline, residential buildings, seasonal cabins, campgrounds, resorts, and rural roads. At the nearest point, the Project area is approximately five miles from the southwestern border of the BWCAW, an area characterized by viewsheds of undeveloped upland forests, open water, and wetlands relatively free from the sights and sounds of human activity. Approximately the same distance to the southwest the viewshed includes active iron mining operations and land uses consistent with iron mining activities and ongoing reclamation. The predominant land cover within a five-mile radius is forested and the viewshed within that radius is dominated by tree cover. The regional terrain reflects historic glaciation and is marked by rolling to hilly areas interspersed with wet lowland depressional areas. Within a mile of the Project area, topographic relief can vary as much as approximately 200 ft (61 m).

3.10 Climate

The climate of the Project area is considered continental. The Project area, and the state of Minnesota as a whole, experiences continental polar air masses throughout the year with frequent outbreaks of arctic air masses pushing south during the winter months. During the summer months, warm and moist air masses often move north from the Gulf of Mexico, especially into the southern part of the state. When a more zonal air flow sets up, Pacific air masses moving across the country from west to east result in relatively mild and dry conditions (NCDC, 2019).

Prevailing wind directions, based on data from Hibbing, Minnesota (Station #94931) (Figure 3-28), are generally from a northwesterly direction. Maximum wind speeds are associated with northwesterly wind directions and the average wind speed for the period of record (01-01-2012 through 12-31-2016) was 7.5 miles per hour (3.37 meters per second).The 30-year normal data from the Ely, Minnesota airport (reported as Babbitt, Minnesota in the dataset) indicates a mean annual temperature of 36.9 degrees (°) Fahrenheit (F) (2.72° Celsius [C]) with monthly mean temperatures ranging from -8.4°F to 77.5°F (-22.4°C to 25.3°C). The coldest month is January with an average low temperature of -8.4 °F (-8 °C) and the warmest month is July with an average high temperature of 77.5 °F (26 °C).

The dataset from the Ely, Minnesota airport indicates that peak precipitation occurs during the months of May through September and ranges from 3.7 to 4.2 inches (7.62 to 10.7 cm) per month and an annual total of 30.2 inches (76.6 cm).

Storm events used for Project facility design include:

- 100-year, 24-hour storm event = 5.5 inches (140.7 mm);
- 10-year, 24-hour storm event = 3.5 inches (88.4 mm); and
- 100-year snow pack melt of 36 to 73 inches producing 10.9 inches (276.8 mm) water equivalent.

3.11 Air

3.11.1 Air Quality

Historically, air quality impacts to this location have been limited to impacts derived from emission sources associated with logging, mineral exploration, and OHV recreation.

In order to assess the baseline ambient conditions in the vicinity of the Project, a review of publicly available data was conducted. The MPCA has ambient monitoring data available for monitoring stations throughout the state and provides air modeling design values for projects in these locations. The current design values are based on data for the most recent full monitoring years of 2015, 2016, and 2017. These design values include specific values for different size fractions of particulate matter (PM), specifically $PM_{2.5}$ and PM_{10}. The 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ ambient background concentrations were acquired from the Ely, Minnesota (Station No. 0005) location, which is relatively close to the Project area. The 24-hour PM_{10} concentrations were obtained from Silver Bay (Station No. 7640-1), near the North Shore process plant site. While this site is located along Lake Superior, this is the closest site that has ambient background concentrations processed for PM_{10}. Given these air monitoring stations are both in the general vicinity of the Project area, they are considered to be representative of background concentrations.

The ambient background levels for 1-hour and annual nitrogen dioxide (NO_2); 24-hour, 3-hour, 1-hour, and annual sulfur dioxide (SO_2); and 1-hour carbon monoxide (CO), and 8-hour CO were determined using data from Rosemount (Station No. 0423) near Minneapolis as the most representative location. This site was used because there are no recent design values available for these gaseous pollutants in northern Minnesota. This monitoring site is also located away from major roadways, so it is considered to be the most representative monitoring location for background conditions in rural northern Minnesota.

Background concentrations are shown in Table 3-15.

3.11.2 Air Quality Standards

Through the federal Clean Air Act (CAA), under Title 42 U.S. Code Section 7401 et seq, the U.S. Environmental Protection Agency (USEPA) has developed National Ambient Air Quality Standards (NAAQS), under Title 40 CFR Part 50, for criteria air pollutants relevant to the Project: NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$, and lead. Under the applicable federal and state regulations, the primary standards are set to protect the

public health, while secondary standards are designed to protect public welfare, including protection from damage to animals, crops, vegetation, visibility, and buildings. The USEPA has delegated authority for implementing these NAAQS standards to the MPCA. In Minnesota, the MPCA has promulgated ambient air standards known as the Minnesota Ambient Air Quality Standards under Minn. R., part 7009.0080. In addition to the criteria pollutants set forth by the USEPA, the Minnesota Ambient Air Quality Standards contain standards for total suspended particulate and hydrogen sulfide.

3.11.3 Ambient Air Quality Attainment Status

Under the CAA, the USEPA has defined all areas within the U.S. as one of two classifications: attainment or non-attainment. Attainment areas are those areas for which ambient air quality data has been collected that demonstrates that they are in compliance, or for which there are insufficient data to demonstrate non-compliance with NAAQS, known as unclassified areas. Various permitting programs, air quality standards, and emissions limits are in place to limit adverse air impacts within attainment areas. An area that does not meet NAAQS requirements for a particular pollutant is classified as a non-attainment area for that pollutant, and the USEPA requires the state to develop implementation plans to control existing and future emissions to bring the area into compliance with the NAAQS. The Project lies in an area that is designated as attainment or unclassified for air quality pollutants. Therefore, the non-attainment requirements are not applicable.

3.12 Noise

The Project would be located within the SNF, an area characterized by manmade noise associated with recreation activities such as OHV use, boating, and vehicle travel, resource management activities such as exploratory drilling and timber harvest, and natural noises such as wind and wildlife activity.

3.12.1 Baseline Ambient Noise

Baseline ambient noise level data was collected by the USFS within the SNF in the vicinity of the Project area between 2014 and 2016. Data provided to TMM by the USFS in September 2017 included a total of 11 measurement sites, five of which were identified as being located proximal to the Project area. Figure 3-29 shows the location of the 11 sites. For the five sites identified as proximal to the Project area, data were collected during winter months (January through March), when human noise producing activity and natural noise producing sources are at a minimum; therefore, the data collected by the USFS during this survey represents the lowest anticipated ambient noise levels that can be expected. Timing of data collection varied at the other six sites and included summer and fall measurements, which provided context for seasonal variation.

Data from three of the 11 collection sites supplied by the USFS were used by TMM to assess baseline ambient noise levels within the vicinity of the Project; these sites included River Point Resort, Spruce Road, and Birch West. River Point Resort was chosen because it would be the closest location to the plant site and this site would be near some of the most important noise-sensitive receptors. Spruce Road was chosen because the data were collected during the fall rather than the winter and may identify seasonal noise variations. Birch West was chosen because measurements there were made in the spring and summer and may also be used to identify seasonal noise variations.

An analysis of the data included an assessment of the 1-hour average calculated from the one-second measure for each location in accordance with Minnesota noise regulation specifically Minn. R., part 7030.0040 which limits noise on a 1-hour average basis. Additionally, the data for each location were used to identify the minimum and maximum values during both daytime and nighttime periods. The results of this analysis are shown in Table 3-16 and indicate times that are very quiet (<20 A-weighted decibel [dBA]) for each location and times that are loud with maximum 1-hour levels reaching 50 to 60 dBA for each area. The average levels for River Point and Spruce Road locations were similar (30 dBA); however, the average at Birch West was 10 dBA louder (40 dBA), potentially indicating seasonal changes in ambient noise levels.

3.12.2 Nearby Sensitive Receptors

A total of 55 nearby sensitive receptors were identified including residences (single-family homes or cabins) to the north and to the west (across Birch Lake reservoir), camping to the north, west, and southwest, and a resort (across Birch Lake reservoir to the northwest) (Figure 3-30).

3.12.3 State Noise Standards

Minnesota establishes noise level limits according to the land use activity at the location of the receiver. Land uses are divided into the following four noise area classifications (NAC):

- NAC 1: Residential housing, religious activities, camping and picnicking areas, health services, hotels, educational services;
- NAC 2: Retail, business and government services, recreational activities, transit passenger terminals;
- NAC 3: Manufacturing, fairgrounds and amusement parks, agricultural and forestry activities; and
- NAC 4: Undeveloped and unused land.

The limits for each NAC are identified in Minnesota Rules, part 7030.0040.

Additionally, humans can feel ground vibration at levels well below thresholds that would cause damage to property. Ground vibration evaluation would consider two aspects: an environmental or acceptable human (annoyance) threshold, and a structural damage threshold.

3.13 Transportation

Annual average daily traffic (AADT) is a measure commonly used to identify baseline traffic conditions for projects that may have transportation implications. *MnDOT's Traffic Mapping Application* (MnDOT, 2018), an interactive web tool that allows users to review spatial traffic data, was used to determine baseline AADT on the following roadways associated with the Project: TH 1, St. Louis CR 21 / CR 120, New Tomahawk Road, NFR 1900, and NFR 1901 shown on Figure 3-31. NFR 1436 and 1493 are secondary access roads and were therefore not considered in the baseline.

3.13.1 Traffic Conditions

The following are baseline traffic conditions for roadways which would be impacted by the Project.

Regional Corridors

The section of TH 1 between the Project area and Ely, Minnesota is a paved two-lane roadway with an AADT volume of 1,150 daily trips. TH 1 to the southeast of the Project is also a paved two-lane roadway with an AADT volume between 375 to 930 daily trips.

The portion of CR 21 / CR 120 between Babbitt, Minnesota and TH 1 is a paved two-lane roadway with AADT volume ranging from 360 daily trips on CR 120 to 1,400 daily trips on CR 21. The portion of CR 21 to the west of Babbitt has an AADT volume of 2,000 daily trips.

New Tomahawk Road is a rural, unpaved two-lane roadway with an AADT of 130.

Local Roads / National Forest Roads

NFR 1900 is located north / northeast of the plant site and intersects TH 1. NFR 1900 is currently an unpaved rural roadway. No AADT information is available for NFR 1900.

NFR 1901 is currently an unpaved rural roadway located north of the plant site. No AADT information is available for this NFR 1901.

3.13.2 Traffic Forecast

Using historic traffic volumes identified from MnDOT's mapping application, traffic forecasts were developed for key regional corridors, local roads, and NFRs, where

data was available. A straight-line growth factor was applied to the historic traffic volumes in order to forecast AADT values in the year 2040. As a result of stable traffic patterns over the previous 10 to 20 years on key regional corridors, the straight-line growth factor that was applied was flat, indicating no growth should be applied to the existing AADT values. The forecast traffic volumes identified by this approach can be found in Table 3-17.

3.13.3 Regional Transportation System

In addition to baseline traffic volumes and forecast traffic volumes, the current condition of regional transportation systems was assessed using the Federal Highway Administration's *Simplified Highway Capacity Calculation Method for the Highway Performance Monitoring System Report* (Margiotta and Washburn, 2017). This approach uses daily traffic volumes to determine a level of service (LOS) that can be applied to individual roadways. Six LOS levels are defined, designated by letters A through F. LOS A represents the best operating conditions (no congestion), and LOS F represents the worst operating conditions (severe congestion).

Application of this method to regional roadways TH 1, New Tomahawk Road, and CR 21 / CR 120 indicates the current designation for these roadways is LOS A.

4.0 ENVIRONMENTAL PROTECTION MEASURES

4.1 General Considerations, Commitments, and Design Criteria

While many environmental protection measures can be categorized as operational, the following general considerations, commitments, and design criteria have been applied to the Project for the purpose of protecting environmental resources from the planning and design stage. The environmental protection measures listed below are generally also included in the following resource-specific sections:

- The Project has been designed as an underground mine to reduce surface disturbance, noise, fugitive dust, light emissions, visual, and surface water-related impacts;
- No mining would occur under Birch Lake reservoir;
- The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water;
- The Project's ore processing circuit has been designed to remove sulfide minerals. Thus, tailings from the Project would not produce ARD.
- No waste rock would be permanently stored on the surface thereby eliminating a potential source of ARD;
- A lined dry stack facility has been selected as a tailings disposal method to reduce ground disturbance, wetland impacts, water appropriation requirements, and the potential for seepage. Additionally, a lined dry stack facility has been selected because it would be highly geotechnically stable;

- After Project closure, no permanent infrastructure, with the exception of the lined dry stack facility and some non-contact water management features, would remain.
- To protect water resources:
  - The potential for run-on would be minimized through implementation of diversion dikes and non-contact water ditches described in Appendix C.
  - The process water pond would be double lined with leak detection as described in 2.13.3;
  - All contact water ponds would be single lined as discussed in Section 2.13.3;
  - contact water ponds would be sized to contain the 100-year, 24-hour storm event. In addition, the collective storage capacity of the contact water ponds for the lined dry stack facility would be sized to meet the stormwater runoff requirements from a 100-year snowpack;
  - The dry stack facility would be lined as described in Section 2.5.5;
  - The dry stack facility would include an under-liner drainage system to protect groundwater resources if seepage occurs as described in Section 2.5.5;
  - The dry stack facility would include over-liner drains and a blanket toe drain to capture draindown intercepted by the liner at the base of the dry stack facility;
  - A cover would be placed on the lined dry stack facility. The cover at closure is anticipated to consist of at least two feet of cover soil underlain by a hydraulic barrier;
  - A grout curtain would be installed during construction of the lined dry stack facility to protect water resources in the event the dry stack facility produces seepage;
  - The lined dry stack facility design avoids direct impacts to Keeley Creek through the implementation of ponds, ditches, and water conveyances and sited to avoid direct impacts to Keeley Creek;
  - Pipes containing petroleum products, liquid reagents, or processing fluids would be double-walled and/or would have a system of leak detection and secondary containment, as determined to be necessary; and
  - reclamation material stockpiles would be covered with wood chips and revegetated to prevent erosion.
- To protect wetland resources:
  - Project infrastructure has been designed and located to minimize potential impacts to wetlands through avoidance; and
  - The lined dry stack facility design and location has been optimized to avoid direct impacts to adjacent wetlands.
- To protect cultural resources:
  - The Project area has been sited and designed to avoid or minimize impacts to cultural resources; and

    - The access road has been sited and designed to reduce impacts to known cultural resources.
- To reduce impacts from noise:
    - The concentrator building and water intake facility have been designed to be higher-grade buildings with a Sound Transmission Class suitable to prevent potential impacts from noise;
    - For the concentrator building and water intake facility, primary ventilation openings would be equipped with standard acoustical louvers;
    - Exhaust outlets on building would be equipped with silencers;
    - The crushers would be located underground;
    - The exhaust ventilation fans for the underground mine would be located underground; and
    - Above-ground conveyor transfer points would be equipped with sound barriers, as needed.
- To reduce impacts to air quality:
    - The coarse ore stockpile would be covered;
    - Conveyors would be covered and water sprays would be provided at transfer points, as needed, to control dust;
    - The crushers would be located underground to reduce dust;
    - Most employees would be transported via bus to the Project from the administration building in Babbitt or the parking lot in Ely to reduce traffic and associated emissions;
    - To reduce dust, concentrate would be loaded into sealed containers within a negative pressure building prior to being transported off-site; and
    - Instead of constructing in-situ power production facilities, a transmission line would be extended from an off-site electrical substation to provide power to the Project.
- To protect visual resources, the potential for visibility of mine structures or activities from high-intensity recreation areas has been reduced:
    - The coarse ore stockpile has been designed to minimize the height of its geodesic dome cover;
    - The comminution circuit and the flotation circuit have been specifically designed to reduce the height of the concentrator building;
    - The mine would be accessed via a decline rather than a shaft, thus eliminating the need for a tall headframe;
    - The lined dry stack facility would be concurrently reclaimed, whereby construction and revegetation would be sequenced to minimize potential effects to the view from Birch Lake reservoir;
    - Building colors would be selected to blend into the surrounding environment; and
    - Steps would be taken to limit light pollution consistent with the Dark Sky Initiative (IDA, 2019).
- To reduce impacts related to surface disturbance:

  - The underground workings would be backfilled with waste rock and engineered tailings backfill to reduce surface disturbance;
  - Ventilation raises would be located on or near existing USFS and exploration drill roads to reduce surface disturbance from new roads;
  - Exhaust ventilation fans would be located underground;
  - Power for the surface ventilation raises would be brought up from the underground mine to minimize surface disturbance associated with transformers and power distribution lines; and
  - Concentrate would be trucked from the plant site to existing port facilities to reduce additional surface disturbance associated with rail-loadout areas
- To prevent subsidence, the Project would operate with an appropriate crown pillar depth.

4.2 Water Resources

4.2.1 General Water Management

The Project would not discharge any process water in accordance with 40 CFR Part 440 and is designed not to require a discharge of contact water through reuse during processing. To reduce potential impacts to water quality, water at the Project would be managed in three different ways to reduce the potential for significant effects to receiving waters.

Contact and process water would consist of any water which has come into contact with ore, tailings, or any portion of the Project operations. This includes process water (i.e. industrial wastewater), seepage (if any), mine inflow water, and tailings runoff. Contact and process water would be routed to contact water ponds, then recycled for use as process water.

Non-contact water would consist of stormwater runoff which has not come into contact with Project operations and is captured in stormwater collection systems. This includes meteoric water, runoff from undisturbed portions or reclaimed portions of the Project area, and stormwater intercepted before contacting contact water. The general approach in managing non-contact stormwater is: to prevent external, non-contact stormwater from mixing with and therefore becoming contact water; to minimize scour and erosion potential; and to minimize total suspended solids and other constituents prior to discharge to surface water.

Domestic, sewage, and sanitary waste waters would be collected and disposed of off-site by a licensed, third-party contractor and would not be included in the Project water management plans.

Additionally, during Project construction, potential impacts to surface water quality would be reduced as described in Section 2.16.15. TMM has prepared a non-contact water management plan and a contact and process water management plan

(Appendix C and Appendix D, respectively). These plans identify more specific control measures for the Project.

4.2.2 Facility-Specific Water Management

The temporary rock storage facility, dry stack facility, and contact water ponds would be single lined with a geomembrane liner. The process water pond would be double lined with HDPE or an engineer-approved alternate geomembrane liner and constructed with a leak detection system to prevent seepage of contact and process water into the groundwater. Process facilities, fuel and reagent storage areas, and hazardous and solid waste storage areas would be constructed with appropriate containment as described in the spill contingency plan (Appendix F).

No waste rock would be permanently stored on the surface thereby negating the need to construct waste rock facilities and reducing potential impacts to water quality related to geochemistry. Process facilities have been designed to minimize surface disturbance, thereby reducing potential impacts to water quality related to erosion. BMPs would be utilized to minimize surface disturbance and erosion potential. These are discussed further in Section 4.10.

Monitoring for surface water and groundwater would be carried out in accordance with a Project monitoring plan. Surface water quality and quantity would be monitored in accordance with applicable permits and would include sampling at upstream and downstream off-site locations. Following are the types of monitoring proposed:

- Background monitoring - Background water quality and surface flow monitoring would be conducted to document surface water quality and quantity upstream of potential Project impacts; and
- Monitor-only – At these types of stations, no limits or standards would apply. However, there may be triggers which could initiate further investigation. These sampling locations for water quality and surface flow would be located downstream of potential Project impacts.

Groundwater monitor wells would be established at the Project, and groundwater quality and groundwater levels (to assess groundwater gradients or changes in groundwater gradients) would be monitored according to permit requirements. Groundwater monitoring data and field observations would be collected and reviewed for the following:

- Compliance monitoring – This would be performed at locations where the Project is required to demonstrate compliance with applicable permit limits. Locations are downgradient of potential Project impacts, typically at or near property boundaries;

- Indicator monitoring – This type of monitoring would be conducted at locations between Project features and the compliance monitoring stations to allow for early detection of potential Project impacts;
- Performance monitoring – This type of monitoring would be performed to assess the performance of engineering infrastructure (e.g., liner systems, containment systems). Performance monitoring stations would include monitoring wells, paired monitoring wells, and paired piezometers; and
- Background monitoring – This type of monitoring would be performed to document groundwater quality upgradient of the Project.

4.3 Air Quality

Process facilities have been designed using a compact layout with underground crushers and enclosed materials handling sites to reduce potential impacts to air quality. Appropriate air quality permits would be obtained from the MPCA for Project facilities and land disturbance. As per MPCA regulations, the Project air quality operating permit must be authorized prior to Project construction.

Air quality practices would include, but may not be limited to, the following:

- A water spray system would be installed at crushers and transfer conveyor areas, and transfer points would be hooded or covered, as determined to be necessary;
- Engineered control equipment would be used (e.g., wet scrubbers, dust collectors, etc.) at process areas requiring dust and/or emission controls, as determined to be necessary;
- Equipment and machinery would be maintained in good working condition to minimize emissions;
- Air velocity would be kept at an optimal level to reduce dust generation from conveyance systems;
- Posted speed limits would be adhered to on Project roads;
- Water would be applied to roads and other disturbed areas to reduce fugitive dust emissions. A chemical dust suppressant application (such as Lignin sulfate or magnesium chloride, or similar product) may be used where appropriate;
- Disturbed areas would be seeded with an interim seed mix to minimize fugitive dust emissions from un-vegetated surfaces, where appropriate;
- Personnel would be bussed from the administration building in Babbitt and the parking lot in Ely to the Project to reduce vehicle emissions; and
- Complete combustion of blasting materials would be ensured through proper blast design protocols.

4.4 Visual Resources and Lighting

The Project has been designed to reduce potential impacts to visual resources as practicable. Visual resource environmental protection measures would include:

- The comminution circuit and the flotation circuit have been designed to reduce the height of the concentrator building;
- The coarse ore stockpile has been designed to minimize the height of its geodesic dome cover;
- Permanent crushers would be located underground and the materials handling sites would be enclosed to reduce potential visual impacts related to dust; and
- Revegetation of the lined dry stack facility would be designed to be ongoing during operations beginning with the face closest to Birch Lake reservoir.

In addition, TMM would apply the following visual resource protection measures throughout the life of the Project:

- TMM would apply lighting mitigation measures that follow the Dark Sky Initiative (IDA, 2019) lighting practices. Specifically, light fixtures would incorporate shields and/or louvers where possible and be full cut-off type;
- Project lighting, where practicable, would be located to avoid light pollution onto adjacent land as viewed from a distance. Light fixtures would be placed at the lowest practical height, would be directed downward, and directed onto operating areas, as necessary;
- The use of dimmers, timers, and motion sensors would be installed where appropriate;
- Buildings would be painted, stained, and/or treated to produce flat-toned, non-reflective surfaces. Facilities would be painted using agency-approved color chart colors, where applicable; and
- Fugitive dust would be minimized in order to reduce “sky glow,” by reducing the light reflectance from dust particles.

4.5 Public Access and Recreation

Public safety would be maintained throughout the life of the Project. To protect public safety, activities would be conducted in conformance with applicable local, state, and federal health and safety requirements. Project visitors would be properly instructed in site safety procedures prior to admittance. TMM would install perimeter fencing and restrict access to the public during operations and appropriate signage would be conspicuously displayed.

4.6 Cultural and Archaeological Resources

The Project has been designed to minimize surface disturbance, thus minimizing potential impacts to cultural and archaeological resources.

Avoidance is the preferred treatment for preventing adverse effects to unevaluated cultural resources and prehistoric or historic sites eligible for listing in the National Register of Historic Places. If avoidance is not feasible, because an area is needed for mine facilities or Project operations, or if avoidance is not adequate to prevent adverse effects, TMM would undertake mitigation such as data recovery at the affected historic properties in accordance with the applicable Programmatic Agreement or Memorandum of Agreement between BLM, Minnesota Historic Preservation Office, and the Advisory Council on Historic Preservation. Development of a treatment plan, data recovery, archaeological and architectural documentation, and report preparation would be based on the "Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation," 48 FR 44716 (September 29, 1983), as amended and annotated, and other guidelines, as appropriate. If an unevaluated site cannot be avoided, additional information would be gathered and the site would be evaluated, as applicable. If the site does not meet eligibility criteria as defined by the National Register Criteria for Evaluation, and/or if the site is determined to have no cultural significance, in particular those identified by Native American tribes, no further cultural work would be performed. If the site meets the eligibility criteria or is determined to have cultural significance, a data recovery plan or appropriate mitigation would be completed under an applicable Programmatic Agreement or Memorandum of Agreement.

To minimize the potential for illegal collection, vandalism, and inadvertent damage, TMM would ensure that its Project personnel and contractors are instructed on cultural resource avoidance and protection measures, including the statutes protecting cultural resources as part of its environmental training program prior to being authorized to work in the Project area.

TMM employees would be trained to identify cultural resources. Training would be administered to new hires and as an annual refresher to current TMM employees using agency-approved materials. If cultural resources are encountered during Project construction, operation, or reclamation, activity in the area of the discovery would cease immediately. The agency Authorized Officer (AO) would be notified and the resource would be evaluated. The results of the evaluation would determine subsequent action.

If construction or other Project personnel discover what may be human remains, funerary objects, or items of cultural patrimony on federally administered public land, construction would cease within the vicinity of the discovery and the county coroner or sheriff would be notified of the find. The location of the find would not be publicly disclosed, and the remains would be secured and preserved in place. TMM or its contractors would immediately notify the agency AO of the discovery, followed by

written notification. Discovered Native American human remains, funerary objects, or items of cultural patrimony found on federally administered public land would be handled in accordance with the Native American Graves Protection and Repatriation Act. Non-Native American human remains would be handled as specified by the AO. Construction would not resume in the area of the discovery until the agency AO has issued a Notice to Proceed.

If any human remains or associated funerary objects are discovered during construction activities on private or non-federal public land, construction would cease within the vicinity of the discovery and the county coroner or sheriff would be notified of the find. The location of the find would not be publicly disclosed, and the remains would be secured and preserved in place. Treatment of discovered human remains (both Native American and non-Native American) and associated artifacts found on private or non-federal public land would be handled in accordance with Minnesota Statute 307.08.

4.7 Biological Resources

To minimize potential impacts related to biological resources resulting from surface disturbance, process facilities have been designed using a compact layout, with crushers located underground and enclosed materials handling sites. Additionally, the Project would use waste rock as backfill material. As such, permanent surface waste rock storage facilities would not be constructed.

Land clearing and surface disturbance activities would be avoided during the avian breeding season, as determined by the agencies, to comply with the Migratory Bird Treaty Act (MBTA) (16 U.S. Code 703-712, as amended). If surface disturbing activities are unavoidable during the avian breeding and nesting season, TMM would have a qualified-biologist survey the proposed disturbance areas for the presence of active nests immediately prior to the disturbance. If active nests are located, or if other evidence of nesting is observed (mating pairs, territorial defense, carrying nesting material, transporting of food), an appropriate buffer would be identified by the agencies, and the buffer would be placed around the nest to prevent destruction or disturbance of nests until the birds are no longer present. Breeding bird survey results would be valid for two weeks.

Operators would be trained to monitor the Project area for the presence of larger wildlife such as deer and sensitive species such as avian wildlife protected under the MBTA. Mortality information would be collected and reported on a quarterly basis in accordance with the MDNR. TMM would establish wildlife protection policies which would prohibit hunting, feeding, or harassment of wildlife.

Fencing would be installed around the tailings management site, plant site, and solution ponds as per guidance set forth by MDNR and USFS.

4.7.1 Threatened and Endangered and Special Status Species

Surveys for threatened, endangered, and special status wildlife and plant species would be conducted for the Project to gather information about general wildlife utilization of the area and the presence or absence of wildlife and plant species of concern. Depending on the survey results, TMM would work with the appropriate agencies to develop appropriate wildlife protection measures relevant for the species which may utilize the area.

4.7.2 Wetlands

TMM would conduct wetland and waterbody delineations for permitting and mitigation purposes including the identification of waters of the United States as defined by the CWA and 40 CFR § 230.3(s). The Project facility locations have been designed to avoid or minimize impacts to wetlands, and to avoid cross-slopes which may increase potential impacts to surface waters.

Any necessary requirements for wetland monitoring would be outlined in the Wetland Conservation Act approval and the CWA Section 404 wetland permit. Wetland monitoring would be designed to monitor direct and potential indirect impacts to wetlands at the Project. Monitoring would include assessing pre-project conditions, establishing hydrology monitoring locations in wetlands, conducting vegetation monitoring, conducting wetland boundary assessments, and comparing results to established impact criteria. Monitoring would assess whether Project activities have directly or indirectly impacted wetland areas. If monitoring identifies additional wetland impacts, provisions would be made to avoid, minimize, or restore wetland impacts, or to provide additional mitigation (Minn. R., § 8420.0520, subpart 6). More details on proposed monitoring requirements would be included in the Project's monitoring plan.

4.8 Subsidence

Initial modeling of subsidence using three-dimensional numerical simulations indicates that surface deformations may manifest as a positive heave above the crown pillar of +1/16 to +1/8 inch (or +2 to 3 mm) with subsidence in the range of -1/24 to -1/16 inch (-1 to -2 mm) over areas where mining occurs at greater depths below ground surface (bgs), assuming average rock mass quality and no backfill (Wood, 2019).

Simulations conducted for the 25-year operation of the Project using the worst-case rock mass quality indicated heave above the crown pillar and subsidence above areas where mining occurs at greater depths would be in the range of ±2/3 inch (or ±16 mm). The extent of these modeled surface deformations would be substantially less than frost heave action of 1.5 inches (38 mm) for a typical 10 ft (3 m) depth of unconsolidated deposit assuming a 35% saturated porosity and frost action down 4 ft (1.2 m).

In the same assessment, stability of the crown pillar was analyzed using the internationally recognized empirical Scaled Span Crown Pillar assessment, as well as numerical modeling. The analysis assessed several configurations of the crown pillar and strength of the rock mass to determine that the crown pillar "would be stable with a Reliability of around 99%" indicating there would be minimal, if any, anticipated impact resulting from crown pillar stability. The results indicated "long-term use is suitable for public access, with limited to no concern regarding conditions on closure."

To prevent subsidence, the project would operate with an appropriate crown pillar depth. Waste rock and engineered tailings backfill would provide confinement to the pillars and ensure long-term stability. More details on proposed monitoring requirements would be included in the Project's monitoring plan.

4.9 Noise

The Project would primarily be classified to be within noise area classification-1 as per Minnesota Administrative Rules Part 7030.0040. This classification would require a nighttime L_{50} (50% of the time period of interest) of 50 dBA or less from the Project at sensitive receptors.

To minimize potential impacts to noise, the following design criteria would be implemented:

- The coarse ore stockpile and conveyors would be covered;
- The concentrator building would be contained within an insulated building. Major openings of the concentrator building would orient away from sensitive noise receptors;
- Insulated housing would be installed over the motors and radiators of the intake fans;
- Exhaust fans would be located underground;
- Permanent crushers would be located underground;
- After the completion of construction, blasting and ore extraction activities would occur underground;
- The ore handling system would utilize conveyors instead of trucks to transport ore to surface;
- Mobile equipment would be relocated as necessary to reduce noise emissions; and
- A berm may be constructed along the edge of the lined dry stack facility nearest sensitive receptors to deflect noise.
- Vibration from blasting activities would be subject to ongoing regulatory controls through the requirements of Minnesota Rules, part 6132.2900, subpart 2.

4.10 Erosion and Sediment Control

Construction stormwater management is discussed in Section 2.16.15. Construction stormwater BMPs would likely include:

- Erosion and sediment control structures such as diversions (e.g., runoff interceptor trenches, check dams, or swales), siltation or filter berms, filter or silt fences, filter strips, sediment barriers, and / or sediment basins.
- Collection and conveyance structures, such as rock-lined ditches and/or swales;
- Vegetative soil stabilization practices such as seeding, mulching, and/or brush layering and matting;
- Non-vegetative soil stabilization practices such as rock and gravel mulches, jute and/or synthetic netting;
- Slope stabilization practices such as slope shaping, and the use of retaining structures and riprap; and
- Infiltration systems such as infiltration trenches and/or basins.

Following construction activities, areas such as cut and fill slopes, embankments, and reclamation material stockpiles would be seeded as soon as practicable and safe. Concurrent reclamation of the lined dry stack facility would be maximized to the extent practicable to accelerate revegetation of disturbed areas. Sediment and erosion control measures would be routinely inspected, and maintenance/repairs performed, as needed.

Specific erosion and sediment control protection measures would include:

- The surfaces of the reclamation material stockpiles would be shaped after construction with overall slopes of 3 horizontal to 1 vertical to reduce erosion;
- To further minimize wind and water erosion, the reclamation material stockpiles would be seeded after shaping with an interim seed mix developed in conjunction with the USFS;
- Diversion channels and/or berms would be constructed around the reclamation material stockpiles as needed to prevent erosion from stormwater runoff;
- BMPs such as straw wattles or staked straw bales would be used at the Project area as necessary to contain sediment liberated from direct precipitation;
- The reclamation material stockpile sediment pond would be used to control sedimentation from stormwater;
- The surface of the lined dry stack facility would be constructed with overall slopes of 4H:1V for stability and to reduce erosion;
- A cover would be placed on the lined dry stack facility to support revegetation. The cover is anticipated to consist of at least two feet of cover soil underlain by a hydraulic barrier; and

- The lined dry stack facility would be concurrently reclaimed during Project operations.

Sediment and erosion control BMPs would be routinely inspected, evaluated for performance, and maintenance and repairs performed, as needed. Repairs would be performed and repairs and additional BMPs would be added as needed.

4.11 Materials and Waste Management

4.11.1 Sanitary and Solid Waste Disposal

Nonhazardous solid wastes generated at the Project would include waste paper, wood, scrap metal, and other domestic trash. These materials would be disposed of at a regulated, off-site landfill contracted by TMM.

As discussed in Section 2.15.2, sewage and sanitary liquid wastes would be collected and disposed off-site by a third-party, licensed contractor. Waste oil and lubricants would be collected and transported off-site by a buyer/contractor for recycling. Reagent containers would be recycled by the reagent supplier. Scrap metal would be sold to a dealer and transported off-site.

Nonhazardous solid wastes from the laboratory would be disposed of in an off-site landfill. Other wastes from the laboratory exhibiting hazardous characteristics, including off-specification commercial chemicals, would be managed as hazardous waste.

Employee training would include appropriate disposal practices such as identifying allowable wastes that can be shipped to a landfill, management of used filters, oily rags, fluorescent light bulbs, aerosol cans, and other regulated substances. Used solvent, liquids drained from aerosol cans, accumulations of mercury fluorescent lights, and used antifreeze may be regulated pursuant to RCRA.

4.11.2 Hazardous Materials Management

The term “hazardous materials” is defined in 49 CFR § 172.101. Hazardous substances are defined in 40 CFR § 302.4 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) Title III. Hazardous materials would be transported to the Project by U.S. DOT regulated transporters and stored on-site in U.S. DOT approved containers. Spill containment structures would be provided for storage containers. Hazardous materials would be managed in accordance with regulations identified in 40 CFR § 262 Standards Applicable to Generators of Hazardous Waste.

Hazardous materials and substances that may be transported, stored, and used at the Project in quantities less than the Threshold Planning Quantity designated by

SARA Title III for emergency planning include blasting components, petroleum products, and small quantities of solvents for laboratory use. Small quantities of hazardous materials not included in the above list may also be managed at the Project; such materials may include commercially produced paints, office products, and automotive maintenance products.

Blasting components would be stored on-site as specified in Section 2.3.7 and Section 2.4.7. Explosive materials would be stored in compliance with applicable federal, state, and local requirements.

Management of hazardous materials at the Project would comply with applicable federal, state, and local requirements, including the inventorying and reporting requirements of Title III of CERCLA, also known as the Emergency Planning and Community Right to Know Act.

Liquid petroleum products and reagents used in the process would be stored in above-ground tanks within a secondary containment area capable of holding 110% of the volume of the largest vessel in a given containment area, per 40 CFR § 267.197.

Fuel and oil for diesel and gas-powered equipment would be stored in above-ground, covered tanks. The tanks would include appropriate secondary containment, as required by state regulation. The refueling hoses would be equipped with overflow prevention devices as well as secondary containment.

Hazardous wastes would be managed in a short-term storage facility within the concentrator building prior to shipment to an off-site licensed disposal facility. These materials may include laboratory waste, waste paints, and thinners. Spent solvents and used oils would be returned to recycling facilities. Waste oil and lubricants would be collected and hauled off-site by a buyer/contractor for recycling. Solvents would be collected by a subcontractor and disposed of or recycled off-site.

A spill contingency plan addressing the handling and containment of hazardous materials anticipated to be used at the Project is presented in Appendix F. The spill contingency plan would be reviewed and updated regularly and when major material management changes are made.

4.11.3 Petroleum Contaminated Soils

Petroleum contaminated soils resulting from spills or leaks of hydrocarbons would be addressed immediately in accordance with the Project's spill contingency plan (Appendix F) and removed from the spill site and stored on the temporary rock storage facility or on an appropriate secondary containment area in accordance with applicable federal and state guidelines prior to disposal. Petroleum contaminated

soils would be shipped to an off-site facility for disposal in accordance with RCRA regulations.

4.12 Protection of Survey Monuments

If they exist, TMM would protect survey monuments, witness corners, reference monuments, bearing trees, and line trees against unnecessary or undue destruction or damage. If, in the course of operations, monuments, corners, or accessories are destroyed, TMM would immediately report the matter to the AO. Prior to destruction or damage during surface disturbing activities, TMM would contact the USFS.

4.13 Fire Management and Protection Procedures

As specified by MSHA, TMM would institute a fire protection training program and would have a rehearsed fire suppression plan. A fire protection system would be installed that would incorporate county and/or state code requirements in the mine services building, concentrator building, and concentrator services building. As required by state and county regulations, water would be reserved for fire protection, as discussed in Section 2.13.3, and would be serviced by dedicated firewater protection pumps and hydrants. Sprinklers systems would be installed as required. On the surface, water trucks used for dust suppression would be available in the event of a fire.

TMM would promptly comply with county, state, and federal emergency directives and requirements pertaining to industrial operations during the fire season.

The following precautionary measures would be taken to prevent wildland fires:

- Light vehicles would be fitted with spark arrestors and would carry firefighting equipment, as required by regulation;
- Vehicle catalytic converters would be inspected often and cleaned of brush and grass debris;
- Vegetation would be periodically cleared from around the transmission line;
- Welding operations would be conducted in an area free of vegetation. A minimum of 10 gal of water (38 liter [L]) and a shovel would be on hand to extinguish spark-related fires. Extra personnel would be at the welding site to watch for fires created by welding sparks;
- Wildland fires would be reported immediately to emergency response personnel by calling 9-1-1. Subsequent reporting would be provided to the MDNR and the Minnesota Interagency Fire Center;
- To the extent known by TMM, the information provided would include the location (latitude and longitude if possible), what is burning, the time the fire started, who/what is near the fire, and the direction of fire spread; and
- TMM would contact the MDNR to find out about fire restrictions in place and to advise this office of approximate beginning and ending dates for exploration activities outside of the Project area.

Because the coarse ore stockpile reclaim tunnel is an enclosed area, sprinklers are required. As this area is exposed to the outside air temperature, a dry sprinkler system would be installed to prevent the lines from freezing.

4.14 Noxious Weeds and Invasive Exotic Species

TMM recognizes the economic and environmental impact that can result from the establishment of noxious weeds and has committed to a proactive approach to weed control. A noxious weed survey would be completed prior to earth moving disturbances. Areas of concern for noxious weeds would be flagged by a weed scientist or qualified biologist to alert personnel to avoid those areas, as practicable. Information and training regarding noxious weeds management and identification would be provided to personnel affiliated with Project implementation and maintenance.

In general, vehicle and heavy equipment which may have been exposed to noxious weeds would be cleaned with a power or high-pressure washer prior to entering or leaving the Project area. Vehicle cleaning would eliminate the transport of vehicle-borne weed seed, roots, or rhizomes. To eliminate the transport of soil-borne noxious weed seeds, soils infested with roots or rhizomes would be stockpiled adjacent to the areas from which they were stripped. Appropriate measures would be taken to avoid wind or water erosion of the affected stockpile. Interim and final seed mixes, hay, straw, and hay/straw products would be certified weed-free from Minnesota and USFS-identified noxious weeds.

Weed monitoring would be conducted for the life of the operation or until the site is released and the reclamation financial surety is released. If the spread of noxious weeds is noted, weed control procedures would be determined in consultation with USFS personnel and would be in compliance with USFS handbooks and applicable laws and regulations.

Mixing of herbicides and rinsing of herbicide containers and spray equipment would be conducted only in areas that are a specified distance from environmentally sensitive areas and points of entry to bodies of water (storm drains, irrigation ditches, streams, lakes, or wells).

5.0 OPERATING PLANS

5.1 Non-Contact Water Management Plan

The non-contact water management plan is included in Appendix C.

5.2 Contact and Process Water Management Plan

The contact and process water management plan are included in Appendix D.

5.3 Rock Characterization and Handling Plan

TMM is currently undertaking a waste characterization program in consultation with the MDNR to support the Project. The results from TMM's waste characterization program would be used to define a rock characterization and handling plan for the Project.

Minnesota Rules, § 6132.1000 and 6132.2200 require geochemical characterization of "mine wastes" from nonferrous mining projects to support the Project's scoping and permitting process. Mine waste is defined broadly by Minnesota Rules § 6132.0100, subpart 16 to mean a "material, such as surface overburden, rock, lean ore, leached ore, or tailings that in the process of mining and beneficiation has been exposed or removed from the earth."

Geochemical characterization is a method for evaluating the reactivity of rock, minerals, and the potential for generation of ARD and metal leaching (ML). ARD is a result of the natural oxidation of sulfide minerals when exposed to air and water. The process of oxidation occurs in series of chemical reactions and in stages, which typically progress from a near neutral state to a more acidic state. The rate at which this reaction occurs can vary based on a number of different environmental factors such as mineral content and climate. Associated geochemical processes can also lead to ML, which is the release of metals into solution.

The ARD and ML potential of Duluth Complex rocks, rocks which host the targeted mineralization, has been studied extensively by the MDNR, USGS, and private industry through both laboratory and field scale testing methodologies (e.g., Kellogg, et., al., 2014; Lapakko et., al., 2013; PolyMet, 2015; Schulte, et., al., 2016; and Wenz, 2016). In particular, MDNR has been conducting ongoing studies since the late 1970s. Many of the studies conducted have incorporated a tool known as kinetic testing, which demonstrates how a rock type weathers over time and allows for the identification of weathering patterns. Analysis of these weathering patterns allows for the identification of whether ARD and ML is produced over time and to what extent. In some cases, kinetic testing has been conducted for more than a decade on Duluth Complex rocks and has led to the following fundamental understanding of the potential for ARD and ML:

- Sulfur content is the controlling factor for the rate and severity of ARD generation from Duluth Complex rocks.
- The silicate minerals (i.e., olivine and calcic plagioclase) present in Duluth Complex rocks are sufficient to maintain approximately non-acidic conditions for extended periods (i.e. decades) for rock with low total sulfur content. For higher total sulfur content rock, silicate minerals have the ability to neutralize the generation of acidity (i.e., neutralization potential) and delay the development of ARD, thereby allowing time for implementation of appropriate engineering controls.
- The potential for ARD is the primary control on ML.

Although a fundamental understanding of the potential for ARD and ML within Duluth Complex rocks exists, TMM has developed a Project-specific material characterization program in consultation with MDNR and in alignment with Minnesota Rules, part 6132.1000. This program is ongoing and can be divided into three components:

- Characterization of sulfide mineralization and ARD and ML potential of tailings, waste rock, development rock, and ore associated with the Duluth Complex and GRB rock;
- Utilization of characterization data to further inform material management; and
- Inclusion of data obtained from the material characterization program into modeling to further understand potential impacts to water quality.

To date, TMM has conducted chemical composition and ARD analysis on development rock, waste rock, ore, and tailings. With respect to development rock and ore, less than 10% of samples tested to date are preliminarily classified as having an ARD potential. Unlike many other ore types, elevated sulfur contents in the Maturi deposit occur almost exclusively in association with the ore with the remainder of samples being classified as waste rock. Ore would be transported to surface and processed and the waste rock that has elevated sulfur, but below ore grade, would be placed in mined out stopes before engineered tailings backfill is pumped into the stope. Planned future testing of the development rock, waste rock, and ore includes continued static testing to inform necessary kinetic testing and additional mineralogical analysis with a specific focus towards the GRB that comprises the footwall, as this is a lesser studied rock unit.

Tailings samples included in the chemical composition and ARD analyses were obtained from pilot plant testing conducted in March 2013. The material source for pilot testing originated from drill core in the western portion of the Maturi deposit. Total sulfur concentrations within the tailings were found to be less than or equal to 0.2 weight percent. These low sulfur concentrations in the tailings occur because most of the sulfur is removed in the flotation process and would be captured as part of the concentrate material (the marketable product). The dominant mineral types found in the tailings are plagioclase, olivine, and pyroxene, which have been shown to provide neutralization potential. Leachate from initial kinetic testing of the tailings material was non-acidic over a 20 week period.

The development and implementation of the materials characterization program is an ongoing effort by TMM which would culminate in documentation which captures the following information:

- A framework for the materials characterization program including common terminology, incorporated references, and commonly used acronyms;

- An overall Project description as it relates to geology, resource development, and anticipated facilities;
- A work plan for the characterization of development rock, ore, and tailings including data quality objectives, testing methods, sample selection rationale, laboratory selection, and data management;
- A work plan for the implementation of the program to include sample group selection and testing proposals; and
- A summary of results broken into static testing, kinetic testing, and field testing.

The current focus of the material characterization program is to continue static testing to further inform where kinetic testing is necessary. Results from future static, kinetic, and field testing would further inform material management and engineering controls, as necessary. In addition to informing material management and engineering controls, data from the material characterization program would be used as an input to future water quality modeling.

TMM would manage Project waste rock, development rock, and ore to provide stable and safe storage in a manner which results in compliance with safety, mining, and environmental regulations.

5.4 Environmental Quality Assurance Plan

The environmental quality assurance plan is included Appendix G.

5.5 Spill Contingency Plan

The spill contingency plan is included as Appendix F.

5.6 Interim Management Plan

The interim management plan is included as Appendix H.

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TABLES

Table 2-1: Project Magnitude Surface Disturbance

Project Feature	Acres
Total Project	1156
Plant Site	153
Tailings Management Site	653
Transmission Corridor	187
Access Road	44
Water Intake Corridor	8
Ventilation Raise Sites and Access Road	15
Non-contact Water Diversion Area	97

Table 2-2: Requirements for Leasable Minerals as per 43 Code of Federal Regulations § 3592

Regulatory Requirement as per 43 CFR § 3592	Specifications Applicable to a Mine Plan of Operations	Location in Document
.1(c)(1)	Names, addresses and telephone numbers of those responsible for operations to be conducted under the approved plan to whom notices and orders are to be delivered, names and addresses of lessees, Federal lease serial numbers and names and addresses of surface and mineral owners of record, if other than the United States.	Section 1.0 – Operator Information Appendix A – Mineral and Surface Ownership Information
.1(c)(2)	A general description of geologic conditions and mineral resources, with appropriate maps, within the area where mining is to be conducted.	Section 3.2 – Geology and Minerals
.1(c)(3)	A copy of a suitable map or aerial photograph showing the topography, the area covered by the lease(s), the name and location of major topographic and cultural features and the drainage plan away from the affected area.	Topography of the Project area is illustrated in Figure 3-13. The area covered by the leases is illustrated in Appendix A – Mineral and Surface Ownership Information. Cultural features are discussed in Section 3.8, and maps identifying cultural resources can be requested from the MDNR or the BLM. Drainage plans for the Project area are included in Appendix C.

Regulatory Requirement as per 43 CFR § 3592	Specifications Applicable to a Mine Plan of Operations	Location in Document
.1(c)(4)	A statement of proposed methods, of operating, including a description of the surface or underground mining methods, the proposed roads, the size and location of structures and facilities to be built, mining sequence, production rate, estimated recovery factors, stripping ratios, and number of acres in the Federal or Indian lease(s), license(s), or permit(s) to be affected.	A description of proposed operations is included in Section 2.0 – Description of Operations As an underground mine, there would be no stripping. Mining sequence and production rates are identified in Figure 2-18 through Figure 2-22, Table 2-11, and Table 2-12. Estimated recovery factors are discussed in Section 2.3. Acres of federal leases affected by the Project are identified in Appendix A – Mineral and Surface Ownership Information. Acres of federal leases affected by the Project identified in Appendix A do not reflect planned surface disturbance.
.1(c)(5)	An estimate of the quantity and quality of the mineral resources, proposed cutoff grade and, if applicable, proposed blending procedures for all leases covered by the mining plan.	An estimate of the quantity and quality of the mineral resources over the 25-year active mine life by production and resource category are included Table 2-11 and Table 2-12. The proposed cutoff grade is discussed in Section 2.3. There are no proposed blending procedures.

Regulatory Requirement as per 43 CFR § 3592	Specifications Applicable to a Mine Plan of Operations	Location in Document
.1(c)(6)	An explanation of how ultimate maximum recovery of the resource will be achieved for the Federal or Indian lease(s). If a mineral deposit, or portion thereof, is not to be mined or is to be rendered un-minable by the operation, the operator/lessee shall submit appropriate justification to the authorized officer for approval.	Section 2.3
.1(c)(7)	Appropriate maps and cross sections showing:	
.1(c)(7)(i)	Federal or Indian lease boundaries and serial numbers.	Appendix A – Mineral and Surface Ownership Information
.1(c)(7)(ii)	Surface ownership and boundaries.	Appendix A – Mineral and Surface Ownership Information
.1(c)(7)(iii)	Locations of existing and abandoned mines.	Figure 2-1
.1(c)(7)(iv)	Typical structure cross sections.	Figure 2-4, Figure 2-6, Figure 2-8, Figure 2-9, Figure 2-10, Figure 2-13, Figure 2-14, Figure 2-15; Figure 2-17, and Figure 2-23
.1(c)(7)(v)	Location of shafts or mining entries, strip pits, waste dumps, and surface facilities.	Figure 2-2, Figure 2-5, Figure 2-11, and Figure 2-16
.1(c)(7)(vi)	Typical mining sequence, with appropriate timeframes.	Mining sequence over the 25-year mine life is identified in Figure 2-18 through Figure 2-22, Table 2-11, and Table 2-12
.1(c)(8)	A narrative which addresses the environmental aspects associated with the proposed mine which includes, at a minimum, the following:	Section 3.0 – Environmental Setting
.1(c)(8)(i)	An estimate of the quantity of water to be used and pollutants that may enter any receiving waters.	This information will be provided in a *Hydrology Characterization Data Package, Volumes 1-3*.
.1(c)(8)(ii)	A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters.	Appendix D – Contact and Process Water Management Plan

Regulatory Requirement as per 43 CFR § 3592	Specifications Applicable to a Mine Plan of Operations	Location in Document
.1(c)(8)(iii)	A description of measures to be taken to prevent or control fire, soil erosion, subsidence, pollution of surface and ground water, pollution of air, damage to fish or wildlife or other natural resources and hazards to public health and safety.	Chapter 4.0 – Environmental Protection Measures
.1(c)(9)	A reclamation schedule and the measures to be taken or surface reclamation of the Federal or Indian lease(s). license(s), or permit(s) that will ensure compliance with the established requirements. In those instances in which the lease requires the revegetation of an area affected by operations, the mining plan shall show:	Appendix B – Reclamation Plan
.1(c)(9)(i)	Proposed methods of preparation and fertilizing the soil prior to replanting.	Appendix B – Reclamation Plan
.1(c)(9)(ii)	Types and mixtures of shrubs, trees or tree seedlings, grasses or legumes to be planted.	Appendix B – Reclamation Plan
.1(c)(9)(iii)	Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees or tree seedlings, or combinations of grasses and trees.	Appendix B – Reclamation Plan
.1(c)(10)	The method of abandonment of operations on Federal or Indian lease(s), license(s), and permit(s) proposed to protect the unmined recoverable reserves and other resources, including the method proposed to fill in, fence or close all surface openings which are a hazard to people or animals. Abandonment of operations also is subject to the provisions of subpart 3595 of this title.	Appendix B – Reclamation Plan

Table 2-3: Approximate Emulsion Quantities

Reagent	Annual Consumption	Delivered Form	Storage	Amount Per Delivery	Anticipated Trucks per month	Approximate Consumption per day
Emulsion (Titan® 7000)	5,500 short tons	Tanker	20 short tons in insulated silo	15 short tons	30	15 short tons

Table 2-4: Primary Mining Equipment

Equipment	Count
Development Jumbo	5
Bolter	9
Loader 18 ton	8
Loader 14 ton	15
Haul Truck 30 ton	5
Haul Truck 40 ton	14
Easer	1
Uphole Production Drill	1
ITH Drill	4
Utility Cassette Carrier	5

Table 2-5: Pre-operational Ore Stockpile Design Parameters and Dimensions Summary

Facility	Inter-Bench Slope (Gradient)	Overall Slope (Gradient)	Lift Height (ft / m)	Max Height Above Original Topo (ft / m)	Crest Elevation (ft amsl)	Surface Area (acres)	Volume
Pre-operational Ore Stockpile	1.3H:1V (38°)	1.8H:1V (29°)	40 / 12	85 / 6	1,540	11.0	722,000 yd^3 / 1,213,000 short ton / 1,100,415 ton

Table 2-6: Primary Fuels

Fuel / Lubricant	Annual Consumption (L per year)	Storage (m^3)	Amount per Delivery (L / st)	Anticipated Trucks/Month	Approximate Consumption per Day (L per day)	Storage Time (days)
Diesel	20,700,000	300	30,000 / 25	58	57,000	5
Gasoline	300,000	20	20,000 / 14.4	2	800	24
Propane	12,700,000	160	10	53	35,000	5

Table 2-7: Primary Reagents

Reagent	Annual Consumption (short tons per year)	Transport Loads (short tons per delivery)	Deliveries per year (approximate)	Storage Capacity (short ton / type)
TETA (triethylenetetramine)	650	19.6	34	25 / Bulk Solution
Na_2SO_3 (Sodium Sulphite)	610	15.4	40	25 / Bags
Aerophine 3418A	60	20.0	3	20 / Bulk Solution
SIPX	1,400	15.4	91	25 / Bags
MIBC	800	16.2	50	30 / Bulk Solution
Lime	10,500	15.4	680	140 / Bulk
Copper Sulphate	600	15.4	39	25 / Bags
Sulfuric Acid	840	20.0	42	32 / Bulk Solution
Flocculant (Concentrate)	3	15.4	8.0	5 / Bags
Flocculant (Tails)	120	with above	with above	with above
Binder (Slag-Cement Mix)	34,000	15.4	2,210	450 / Bulk

Table 2-8: Plant Site Reclamation Material Stockpiles Design Parameters and Dimensions Summary

Facility	Inter-Bench Slope (Gradient)	Overall Slope (Gradient)	Lift Height (ft / m)	Max Height Above Original Topo (ft / m)	Crest Elevation (ft amsl)	Surface Area (acres)	Volume
Reclamation Material Stockpile 1	50%	33%	23 / 7	31 / 9.4	1,532	2.2	65,430 yd^3 / 77,200 short tons / 70,035 tonne
Reclamation Material Stockpile 2	50%	33%	23 / 7	23t / 7	1,516	2.7	45,780 yd^3 / 54,020 short tons / 49,006 tonne

Table 2-9: Surface Mobile Equipment

Mobile Equipment	Number of Units
Plant Site	
Tool Handler	1
Bobcat	1
Pick-up Truck	11
Boom Truck	1
Front-end Loader	1
Electrician Vehicle	1
30 T Mobile Crane	1
Grader	1
Water tanker	1
Vibratory Packer	1
Ambulance	1
Fire Truck	1
Tailings Management Site	
60 Ton Trucks	12
Front End Wheel Loader	3
Vibratory Roller Compactors	3
Dry Stack Facility Dozers	3
Graders	2
Water Trucks	3
Bob Cat	2
Fork Lift	2
Flat Bed Truck	2
Pickup Truck	5

Table 2-10: Tailings Management Site Reclamation Material Stockpile Design Parameters and Dimensions Summary

Facility	Inter-Bench Slope* (Gradient)	Overall Slope (Gradient)	Lift Height (ft)	Max Height Above Original Topo (ft)	Crest Elevation (feet)	Surface Area (acres)	Volume (yd^3)
Tailings Management Site Reclamation Material Stockpile	N/A	3H:1V	N/A	50	1,534	16	871,000

Table 2-11: Mine Plan Summary Based on Production

Time	Stope (Mt)	% Copper	% Nickel	Cobalt ppm	Gold ppm	Lead ppm	Platinum ppm	Silver ppm
Total	*163.3*	--	--	--	--	--	--	--
Average	--	*0.69*	*0.22*	*110*	*0.10*	*0.44*	*0.19*	*2.51*
Year 1	5.54	0.76	0.24	130	0.09	0.33	0.14	2.72
Year 2	6.62	0.81	0.26	130	0.09	0.36	0.15	2.90
Year 3	6.62	0.78	0.25	130	0.09	0.33	0.14	2.74
Year 4	6.57	0.73	0.24	130	0.08	0.32	0.14	2.59
Year 5	6.54	0.73	0.24	120	0.09	0.33	0.14	2.58
Year 6	6.61	0.75	0.24	120	0.09	0.33	0.14	2.63
Year 7	6.58	0.72	0.24	120	0.08	0.32	0.14	2.51
Year 8	6.62	0.68	0.23	120	0.08	0.33	0.14	2.41
Year 9	6.62	0.70	0.24	110	0.10	0.39	0.18	2.54
Year 10	6.62	0.71	0.24	110	0.10	0.39	0.17	2.61
Year 11	6.62	0.72	0.24	110	0.10	0.42	0.19	2.61
Year 12	6.62	0.70	0.24	110	0.10	0.39	0.18	2.52
Year 13	6.62	0.70	0.24	110	0.10	0.42	0.19	2.54
Year 14	6.62	0.72	0.23	110	0.10	0.46	0.20	2.69
Year 15	6.61	0.69	0.22	100	0.11	0.49	0.21	2.59
Year 16	6.53	0.68	0.21	100	0.12	0.52	0.22	2.51
Year 17	6.51	0.68	0.20	100	0.14	0.64	0.28	2.56
Year 18	6.58	0.65	0.19	90	0.13	0.62	0.27	2.46
Year 19	6.56	0.66	0.19	90	0.13	0.61	0.27	2.53
Year 20	6.62	0.61	0.18	90	0.12	0.55	0.24	2.29
Year 21	6.62	0.57	0.16	90	0.11	0.51	0.23	2.11
Year 22	6.58	0.65	0.20	100	0.11	0.50	0.22	2.40
Year 23	6.62	0.66	0.20	100	0.11	0.50	0.23	2.41
Year 24	6.44	0.64	0.20	100	0.11	0.48	0.22	2.29
Year 25	6.22	0.60	0.19	100	0.10	0.45	0.20	2.15

Table 2-12: Mine Plan Summary Based on Resource Category

Mineral Leases (Stopes)						
Year	**Federal (Mt)**	**State (Mt)**	**Private (Mt)**	**Federal (%)**	**State (%)**	**Private (%)**
Total	*99.9*	*58.2*	*5.2*	--	--	--
Average	--	--	--	*61*	*36*	*3*
Year 1	5.54	0.00	0.00	100	0	0
Year 2	6.62	0.00	0.00	100	0	0
Year 3	6.36	0.26	0.00	96	4	0
Year 4	6.31	0.27	0.00	96	4	0
Year 5	5.92	0.62	0.00	90	10	0
Year 6	5.90	0.71	0.00	89	11	0
Year 7	5.65	0.92	0.01	86	14	0
Year 8	5.82	0.70	0.10	88	11	2
Year 9	4.67	1.79	0.16	70	27	2
Year 10	4.12	2.45	0.05	62	37	1
Year 11	3.64	2.83	0.16	55	43	2
Year 12	2.65	3.82	0.14	40	58	2
Year 13	3.20	3.01	0.41	48	46	6
Year 14	4.40	0.94	1.29	66	14	19
Year 15	4.86	1.28	0.47	74	19	7
Year 16	4.65	1.76	0.12	71	27	2
Year 17	2.58	3.84	0.09	40	59	1
Year 18	2.60	3.59	0.38	40	55	6
Year 19	1.89	4.47	0.19	29	68	3
Year 20	2.30	3.87	0.45	35	58	7
Year 21	2.70	3.46	0.46	41	52	7
Year 22	1.56	4.96	0.07	24	75	1
Year 23	1.49	5.13	0.00	23	77	0
Year 24	2.51	3.69	0.24	39	57	4
Year 25	2.00	3.82	0.40	32	61	6

Table 2-13: Labor Profile

Department	Payroll
General and Administrative	62
Underground Mine	537
Plant Site	99
Tailings Management Site	67
TOTAL	*765*

Table 2-14: Contact Water Pond Dimensions

Contact Water Pond	Catchment Area Size (acre / hectare)	Pond Volume (g / m^3)	Pond Footprint (ft^2 / m^2)	Average depth (ft / m)
Plant Site North contact water pond	42.7 / 17.3	6,384,510 / 24,168	91,493 / 8,500	9.3 / 2.84
Plant Site Central contact water pond	41.5 / 16.8	23,470	97,144 / 9,025	8.5 / 2.60
Plant Site South contact water pond	42.7 / 17.3	6,384,510 / 24,168	94,453 / 8,775	9.0 / 2.75
dry stack facility CWP1	252.3 / 102.1	66,021,087 / 249,917	711,247 / 66,077	13.9 / 4.25
dry stack facility CWP2	47.0 / 19.0	7,938,106 / 30,049	75,207 / 6,987	13.1 / 4.00
dry stack facility CWP3	98.8 / 40.0	12,447,259 / 47,118	110,890 / 10,302	20.0 / 6.10
dry stack facility CWP4	79.3 / 32.1	11,290,978 / 42,741	266,784 / 24,785	5.9 / 1.80
dry stack facility CWP5	115.4 / 46.7	14,118,940 / 53,446	368,535 / 34,238	5.9 / 1.80
dry stack facility contact water pond.I1	35.3 / 14.3	4,787,854 / 18,124	70,966 / 6,593	5.2 / 1.60
dry stack facility contact water pond.I2	41.5 / 16.8	12,056,284 / 45,638	174,354 / 16,198	9.2 / 2.80

768 Table 3-1: Natural Resources Conservation Service Map Unit Descriptions

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
1003B	Udorthents, loamy (cut and fill land)	6	No	fills on moraines, beveled cuts on moraines	Well drained	Low	Not defined	Not defined
1020A	Bowstring and Fluvaquents, loamy, 0 to 2 percent slopes, frequently flooded	26	Yes	flats on flood plains	Very poorly drained	High	Low	High
1021A	Rifle soils, 0 to 1 percent slopes	82	Yes	swamps on end moraines, swamps on outwash plains, swamps on till plains	Very poorly drained	High	High	High
1022A	Greenwood soils, 0 to 1 percent slopes	21	Yes	bogs on end moraines, bogs on outwash plains, bogs on till plains	Very poorly drained	High	High	High

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
F10D	Cloquet-Pequaywan complex, 0 to 18 percent slopes, pitted	24	No	pitted outwash plains	Well drained	Low	High	High
F10E	Cloquet-Pequaywan complex, 0 to 45 percent slopes, pitted	59	No	pitted outwash plains	Well drained	Low	High	High
F166A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	3	Yes	drainageways on moraines	Very poorly drained	High	Moderate	High
F19A	Pequaywan loam, 0 to 3 percent slopes	12	No	rises on outwash plains, flats on outwash plains	Moderately well drained	Moderate	High	Moderate
F21D	Quetico, stony-Rock outcrop complex, 15 to 35 percent slopes	11	No	moraines	Well drained	Low	High	Moderate
F22F	Eveleth-Conic complex, 20 to 50 percent slopes, very bouldery	2	No	moraines	Well drained	Moderate	High	Moderate

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
F23B	Rollins-Biwabik complex, 1 to 8 percent slopes, very rocky	20	No	moraines	Somewhat excessively drained	Low	High	Moderate
F25D	Rollins-Cloquet complex, 8 to 18 percent slopes	484	No	pitted outwash plains	Somewhat excessively drained	Low	High	Moderate
F29E	Shagawa, extremely stony-Beargrease, extremely stony-Tacoosh complex, 0 to 35 percent slopes	164	No	end moraines	Well drained	Low	High	Moderate
F2B	Eaglesnest-Wahlsten complex, 2 to 8 percent slopes, bouldery	342	No	moraines	Moderately well drained	Moderate	High	Moderate
F35D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly, complex, 0 to 18 percent slopes	73	No	moraines	Well drained	Moderate	High	Moderate

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
F3D	Eveleth-Eagelsnest-Conic complex, bouldery, 6 to 18 percent slopes, very rocky	23	No	moraines on till plains	Well drained	Moderate	High	Moderate
F40D	Rollins cobbly sandy loam, 8 to 18 percent slopes	10	No	kames, outwash plains	Somewhat excessively drained	Low	High	Moderate
F4E	Eveleth-Conic, bouldery-Rock outcrop complex, 18 to 30 percent slopes	25	No	moraines	Well drained	Moderate	High	Moderate
F5B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes, rocky	8	No	till plains on moraines	Somewhat poorly drained	High	High	High
F8D	Biwabik-Graycalm-Friendship complex, 0 to 18 percent slopes, pitted	22	No	pitted outwash plains	Excessively drained	Low	High	Moderate

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
F9B	Cloquet loam, 2 to 8 percent slopes	33	No	outwash plains	Well drained	Low	High	High
I2a10C	Quetico, bouldery-Insula, bouldery-Rock outcrop complex, 3 to 18 percent slopes	305	No	moraines on till plains	Moderately well drained	Moderate	High	High
I2a10D	Quetico, stony-Rock outcrop complex, 15 to 35 percent slopes	67	No	moraines	Well drained	Low	High	Moderate
I2a23G	Conic, very bouldery-Insula, very bouldery-Rock outcrop complex, 20 to 70 percent slopes	83	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
I2a31D	Eveleth-Eagelsnest-Conic complex, bouldery, 6 to 18 percent slopes, very rocky	158	No	moraines on till plains	Well drained	Moderate	High	Moderate

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
I2b19A	Babbitt, bouldery-Aquepts, rubbly complex, 0 to 3 percent slopes	401	No	rises on moraines	Somewhat poorly drained	Moderate	High	High
I2b20B	Babbitt, bouldery-Wahlsten, bouldery-Aquepts, rubbly, complex, 0 to 8 percent slopes, rocky	137	No	till plains on moraines	Somewhat poorly drained	High	High	High
I2b21D	Eveleth, bouldery-Conic, bouldery-Aquepts, rubbly complex, 0 to 18 percent slopes, very rocky	2106	No	moraines	Well drained	Moderate	High	Moderate
I3-11A	Aquepts, rubbly-Tacoosh-Rifle complex, 0 to 2 percent slopes	203	Yes	drainageways on moraines	Very poorly drained	High	Moderate	High
J1a40A	Greenwood soils, dense substratum, 0 to 1 percent slopes	1151	Yes	bogs on moraines	Very poorly drained	High	High	High

NRCS Map Unit	Unit Name	Acres Within the Project Area[1]	Hydric Soil	Geomorphic Description	Drainage Characteristics	Susceptibility to Frost Heaving	Susceptibility to Corrosion - Concrete	Susceptibility to Corrosion - Steel
J2-40A	Cathro muck, depressional, dense substratum, 0 to 1 percent slopes	39	Yes	depressions on moraines	Very poorly drained	High	High	High
K1-10	Pits, gravel-Udipsamments complex	7	Undefined	Undefined	Undefined	Undefined	Undefined	Undefined
K2-10A	Bowstring and Fluvaquents soils, 0 to 2 percent slopes, frequently flooded	166	Yes	flats on flood plains	Very poorly drained	High	Moderate	High

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.

772 Table 3-2: Ecological Land Type Map Unit Descriptions

Ecological Landtype Unit	Landtype Phase	Acres Within the Project Area[1]
1	Poorly drained, loamy soils, greater than 40 inches deep, surface coarse fragment content ranges from 25 to 90 percent in drainways and depressions.	291
4	Poorly and very poorly drained fibrist greater than 60 inches deep, occurring in depressions and former lake beds.	458
5	Well drained, 2.5 yellow-red to 10 yellow-red, sandy loam or loam 8 inches deep over bedrock, occurring on ridge top and upper slope positions. Bedrock out-cropping can range from 5-50 percent.	390
7	Somewhat poorly drained, 10 yellow-red or 2.5 yellow-red, sandy loam, loam and/or silt loam greater than 40 inches deep, occurring in drainways, lower concave slopes, and in a transitional position between well drained and poorly drained sites. Coarse fragment content can range to 35 percent.	111
10	Moderately well or well drained, 10 yellow-red to 2.5 yellow sandy loam and/or loam greater than 40 inches deep, occurring on ridge positions. Clay content is less than 18 percent. B horizons are 10 yellow-red.	68
14	Well drained 7.5 yellow-red or 10 yellow-red sandy loam and loamy sand, greater than 50 percent fine sand, less than 20 inches deep over 10 yellow-red, gravelly coarse sand greater than 40 inches deep, with greater than 35 percent coarse fragments. Landscape position is upper elevation in outwash plain. Sand size includes fine through very coarse.	296

Ecological Landtype Unit	Landtype Phase	Acres Within the Project Area[1]
18	Well drained, 5 yellow-red to 10 yellow-red, sandy loam and/or loam, 20 to 40 inches deep over bedrock, occurs on bedrock controlled ridges.	1642
21	Well drained, 10 yellow-red to 2.5 yellow-red, sandy loam or loam 8 to 20 inches deep over bedrock, 7.5 yellow-red B horizons are common. Controlled ridge tops and upper slopes	1076
24	Poorly drained, hemist greater than 53 inches deep, occurring in depressions and former lake beds.	816
28	Well drained 10 yellow-red loamy sand or loamy fine sand less than 12 inches deep with over 2.5 yellow-red to 2.5 yellow sand greater than 40 inches deep occurring upper elevation positions on outwash or lacustrine plains. Sand in size includes fine through very coarse. Gravel content is less than 35 percent.	30
30	Well drained, 7.5 yellow-red or 5 yellow-red, fine sandy loam, 16 to 24 inches deep over 10 yellow-red, very gravelly sandy loam or very gravelly loamy sand, greater than 40 inches deep and occurring on ridges. A discontinuous fragipan can occur at 16-24 inches. Coarse fragment content of the C horizon ranges from 35 to 50 percent.	267
32	Poorly drained, organic material 18 to 53 inches deep over mineral soils occurring in drainways and depressions.	51
46	Moderately well drained 5 yellow-red to 10 yellow-red sandy loam or loamy sand less than 20 inches deep over gravelly sand. Water table and/or mottling within 60 inches. Coarse fragment content is variable. Landscape position lower elevation concave areas in an outwash glacial drainages and terraces.	1

Ecological Landtype Unit	Landtype Phase	Acres Within the Project Area[1]
47	Poorly drained, 10 yellow-red or 2.5 yellow-red, sandy loam, loam, clay loam, and/or silt loam greater than 40 inches deep, occurs in drainways and depressions. Histic epipedons can occur. Surface coarse fragment content is less than 25 percent.	194
89	Water (lake or river), intermittent water body	39
99	Gravel pit, landfill, or quarry	7
Site Units	**Site Descriptions**	
BR	Bedrock	
GP	Gravel Pit	
INT	Intermittent Water Body	
LF	Landfill	
NM	Not Mapped	
Q	Quarry	
W	Water	
Slope Qualifiers	**Slope Descriptions**	
No symbol	Less than 6 percent	
A	0 to 6 percent	
B	7 to 18 percent	
C	19 to 35 percent	
D	36 to 50 percent	
E	51 plus percent	

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets.

Table 3-3: Project Component Watersheds

	Project Area[1]	Underground Mine Area	Plant Site	Tailings Management Site	Transmission Corridor	Non-Contact Water Diversion Area	Water Intake Corridor	Ventilation Raises and Ventilation Access Road	Access Road
Minnesota Department of Natural Resources Minor Watershed (acres)									
South Kawishiwi River	3926.2	1735.5	152.9	121.4	111.0	62.3	7.5	14.9	43.6
Keeley Creek	1274.7			532.0	9.5	34.3			
Filson Creek	327.7	125.9							
unknown	317.6	125.1							
Stony River	260.4				38.9				
Denley Creek	180.6				27.6				
U.S. Geological Survey HUC12 (acres)									
Birch Lake	5200.9	1735.5	152.9	653.4	120.5	96.6	7.5	14.9	43.6
South Kawishiwi River	645.3	251.0							
Outlet Stony River	260.4				38.9				
Denley Creek	180.6				27.6				

Table 3-4: Public Water Basins within 1 Mile of the Project Area

County	Public Water Identification #	Public Waters Name	Section	Township	Range
Lake	38-774P	Unnamed	31	61	11
Lake	38-775P	Unnamed	31	61	11
St. Louis/Lake	69-3P	Birch Lake	Various	60; 61	11; 12; 13

Table 3-5: Public Watercourses within 1 Mile of the Project Area

County	Name
Lake	South Fork Kawishiwi River
Lake	Keeley Creek
Lake	Denley Creek
Lake	Stony River
St. Louis	Dunka River

Table 3-6: Minnesota National Wetland Inventory Simplified Plant Community Classification Baseline

Wetland Type	Baseline Acres[1]
Project area	
Coniferous Bog	818.7
Hardwood Wetland	110.5
Non-Vegetated Aquatic Community	60.9
Open Bog	360.3
Seasonally Flooded/Saturated Emergent Wetland	26.7
Shallow Marsh	169.5
Shallow Open Water Community	5.5
Shrub Wetland	187.2
Total	1739.3

Notes:
[1] Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 3-7: Minnesota National Wetland Inventory U.S. Fish and Wildlife Service Circular 39 System Baseline

Wetland Type	Baseline Acres[1]
Project area	
Type 1 Seasonally flooded basins or flats	3.9
Type 2 Wet Meadows	22.8
Type 3 Shallow Marsh	169.5

Wetland Type	Baseline Acres[1]
Project area	
Type 4 Deep Marsh	8.3
Type 5 Shallow Open Water	38.5
Type 6 Shrub Swamp; Shrub Carr, Alder Thicket	187.2
Type 7 Wooded Swamps; Hardwood Swamp, Coniferous Swamp	110.5
Type 8 Bogs; Coniferous Bogs, Open Bogs	1179.1
90 Rivers and streams	19.6
Total	1739.4

Notes:
1 Minor differences in acreages between tables are due to variations in the spatial resolution of underlying datasets and rounding.

Table 3-8: U.S. Geological Survey GAP / LANDFIRE Data Baseline

GAP Classification	Baseline Acres
Project area	
Boreal Aspen-Birch Forest	207.8
Boreal Jack Pine-Black Spruce Forest	503.6
Boreal White Spruce-Fir-Hardwood Forest	2625.6
Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen	2614.6
Cultivated Cropland	1.4
Developed, High Intensity	19.3
Developed, Low Intensity	1.3
Developed, Open Space	3.1
Eastern Boreal Floodplain	4.6
Harvested Forest - Grass/Forb Regeneration	3.3
Laurentian-Acadian Floodplain Systems	20.4
Laurentian-Acadian Northern Hardwoods Forest	26.8
Laurentian-Acadian Northern Pine-(Oak) Forest	115.9
Laurentian-Acadian Swamp Systems	55.6
Open Water (Fresh)	63.6
Quarries, Mines, Gravel Pits and Oil Wells	21.4
Total	6288.4

Table 3-9: National Land Cover Data Baseline

National Land Cover Data Classification	Baseline Acres
Project area	
Deciduous Forest	283.1
Developed, Open Space	192.7
Developed, Low Intensity	0.4
Emergent Herbaceous Wetlands	78.2
Evergreen Forest	2025.9
Grassland/Herbaceous	145.4
Mixed Forest	568.8
Open Water	58.7
Shrub/Scrub	494.7
Woody Wetlands	2439.1
Total	6287.2

800 Table 3-10: Minnesota Department of Natural Resources Minnesota Biological Survey Data Baseline

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Baseline Acres[1]
Project area			
APn81a	Poor Black Spruce Swamp	S5	437.8
APn81b	Poor Tamarack - Black Spruce Swamp	S4	64.3
APn81b1	Poor Tamarack - Black Spruce Swamp, Black Spruce Subtype	S4	5.9
APn81b2	Poor Tamarack - Black Spruce Swamp, Tamarack Subtype	S4	88.1
APn91a	Low Shrub Poor Fen	S5	207.0
APn91b	Graminoid Poor Fen (Basin)	S3	4.1
	Acid Peatland System Total		*807.3*
CTn32a	Mesic Mafic Cliff (Northern)	S3	2.0
	Cliff/Talus System Total		*2.0*
BW_CX	Beaver Wetland Complex		50.2
	Beaver Wetland Complex Total		*50.2*
MF_PDMW_CX	Poor Dry-Mesic Woodland_Mesic Forest Complex		469.8
	Mesic Woodland/Mesic Forest Complex Total		*469.8*
FDn32	Northern Poor Dry-Mesic Mixed Woodland		248.3
FDn32a	Red Pine - White Pine Woodland (Canadian Shield)	S3	61.9
FDn32c	Black Spruce - Jack Pine Woodland	S2 or S3	1048.8
FDn32c1	Black Spruce - Jack Pine Woodland, Jack Pine - Balsam Fir Subtype	S2	20.4
FDn33	Northern Dry-Mesic Mixed Woodland		24.8
FDn33a	Red Pine - White Pine Woodland	S3	65.1
FDn43	Northern Mesic Mixed Forest		4.0
FDn43a	White Pine - Red Pine Forest	S2	116.5
FDn43b1	Aspen - Birch Forest, Balsam Fir Subtype	S5	122.2

Type/Subtype Code	Type/Subtype Name Community total	S-Rank	Baseline Acres[1]
FDn43b2	Aspen - Birch Forest, Hardwood Subtype	S5	4.0
	Fire-Dependent Forest/Woodland System Total		*1715.9*
FPn62a	Rich Black Spruce Swamp (Basin)	S3	70.2
	Forested Rich Peatland System Total		*70.2*
OPn81	Northern Shrub Shore Fen		2.2
OPn81b	Leatherleaf - Sweet Gale Shore Fen	S5	27.8
OPn91	Northern Rich Fen (Water Track)		4.8
	Open Rich Peatland System Total		*34.9*
WFn55a	Black Ash - Aspen - Balsam Poplar Swamp (Northeastern)	S4	20.7
WFn64c	Black Ash - Alder Swamp (Northern)	S4	8.2
	Wet Forest System Total		*29.0*
WMn82b1	Sedge Meadow, Bluejoint Subtype	S5	41.4
	Wet Meadow/Carr System Total		*41.4*
	Total		3220.7

Notes:
[1] MBS NPC / candidate data is not available for the full Project area. Southwest portion of the transmission corridor has not been mapped.
Abbreviations:
MBS = Minnesota Biological Survey
NPC = Native Plant Community

807

Table 3-11: Terrestrial Vegetative Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Fungus							
Sarcosoma globosum	A Cup Fungus	none	special concern			Fire Dependent Forest	X
Lichen							
Ahtiana aurescens	Eastern candlewax lichen	none	special concern		Yes	Forested Rich Peatland	X
Allocetraria oakesiana	Yellow ribbon lichen	none	threatened	Yes		Fire Dependent Forest	X
Bryoria fuscescens	Pale-footed Horsehair Lichen	none	special concern			Fire Dependent Forest, Forested Rich Peatland, Non-Forested Acid Peatland	X
Lobaria scrobiculata	Textured lungwort	none	endangered	Yes		Forested Rich Peatland	X
Melanohalea subolivacea	Brown-eyed Camouflage Lichen	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Menegazzia terebrata	Port-hole Lichen	none	special concern			Forested Rich Peatland	X
Ochrolechia androgyna	Powdery Saucer Lichen	none	special concern			Fire Dependent Forest, Forested Rich Peatland	X
Peltigera venosa	Fan lichen	none	special concern			Fire Dependent Forest	X
Protopannaria pezizoides	Brown-gray Moss-shingle Lichen	none	threatened	Yes		Forested Rich Peatland	X
Pseudocyphellaria holarctica	Yellow specklebelly lichen	none	endangered			Fire Dependent Forest, Mesic Hardwood Forest	X
Ramalina thrausta	Angel's Hair Lichen	none	special concern			Forested Rich Peatland	X
Sticta fuliginosa	Peppered moon lichen	none	special concern	Yes		Forested Rich Peatland	X
Thelocarpon epibolum	A Species of Thelocarpon Lichen	none	special concern			Fire Dependent Forest, Forested Rich Peatland	X
Usnea longissima	Methuselah's Beard Lichen	none	special concern			Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland	X
Moss							
Buxbaumia aphylla	Bug-on-a-stick Moss	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest, Non-Forested Rich Peatland	X
Frullania selwyniana	Selwyn's Ear-leaf Liverwort	none	special concern			Forested Rich Peatland	X

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Sphagnum compactum	Cushion Peat Moss	none	threatened			Fire Dependent Forest, Forest Acid Peatland	X
Splachnum rubrum	Red Parasol Moss	none	endangered	Yes		Forest Acid Peatland, Forested Rich Peatland, Non-Forested Acid Peatland	X
Vascular Plant							
Achillea alpina	Siberian Yarrow	none	threatened			Fire Dependent Forest	X
Botrychium lunaria	Common Moonwort	none	threatened	Yes	Yes	Fire Dependent Forest	X
Botrychium minganense	Mingan Moonwort	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Botrychium mormo	Goblin Fern	none	threatened	Yes		Mesic Hardwood Forest	X
Botrychium oneidense	Blunt-lobed Grapefern	none	threatened		Yes	Mesic Hardwood Forest	X
Botrychium pallidum	Pale Moonwort	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Botrychium rugulosum	St. Lawrence Grapefern	none	special concern		Yes	Fire Dependent Forest	X
Botrychium simplex	Least Moonwort	none	special concern			Mesic Hardwood Forest	X
Botrychium spathulatum	Spatulate Moonwort	none	endangered			Fire Dependent Forest	X
Caltha natans	Floating Marsh Marigold	none	endangered	Yes		Non-Forested Rich Peatland	X
Cardamine pratensis	Cuckoo Flower	none	threatened	Yes		Forested Rich Peatland, Non-Forested Rich Peatland	X
Carex exilis	Coastal Sedge	none	special concern			Non-Forested Acid Peatland	X
Carex michauxiana	Michaux's Sedge	none	special concern			Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland	X
Carex ormostachya	Necklace Sedge	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Cladium mariscoides	Twig Rush	none	special concern			Non-Forested Rich Peatland	X
Crataegus douglasii	Black Hawthorn	none	special concern			Fire Dependent Forest	X
Cypripedium arietinum	Ram's Head Orchid	none	threatened	Yes		Fire Dependent Forest, Forested Rich Peatland	X
Drosera anglica	English Sundew	none	special concern			Non-Forested Rich Peatland	X
Eleocharis flavescens var. olivacea	Olivaceous Spikerush	none	threatened			Non-Forested Acid Peatland	X

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Eleocharis quinqueflora	Few-flowered Spikerush	none	special concern			Non-Forested Rich Peatland, Non-Forested Acid Peatland	X
Gymnocarpium robertianum	Northern Oak Fern	none	special concern			Forested Rich Peatland	X
Huperzia porophila	Rock Fir Moss	none	threatened	Yes		Mesic Hardwood Forest	X
Juncus stygius var. americanus	Bog Rush	none	special concern			Non-Forested Rich Peatland, Non-Forested Acid Peatland	X
Listera convallarioides	Broad-leaved Twayblade	none	special concern			Forested Rich Peatland	X
Luzula parviflora	Small-flowered Woodrush	none	threatened	Yes		Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland	X
Malaxis monophyllos var. brachypoda	White Adder's Mouth	none	special concern			Forested Rich Peatland	X
Malaxis paludosa	Bog Adder's Mouth	none	endangered			Forested Rich Peatland	X
Moehringia macrophylla	Large-leaved Sandwort	none	threatened	Yes		Fire Dependent Forest	X
Muhlenbergia uniflora	One-flowered Muhly	none	special concern			Non-Forested Acid Peatland	X
Osmorhiza berteroi	Chilean Sweet Cicely	none	endangered	Yes		Mesic Hardwood Forest	X
Osmorhiza depauperata	Blunt-fruited Sweet Cicely	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Phacelia franklinii	Franklin's Phacelia	none	threatened		Yes	Fire Dependent Forest	X
Piptatherum canadense	Canadian Ricegrass	none	threatened	Yes		Fire Dependent Forest	X
Platanthera clavellata	Small Green Wood Orchid	none	special concern		Yes	Forest Acid Peatland, Forested Rich Peatland	X
Polystichum braunii	Braun's Holly Fern	none	threatened	Yes		Fire Dependent Forest, Mesic Hardwood Forest	X
Potamogeton confervoides	Algae-like Pondweed	none	endangered	Yes		Non-Forested Acid Peatland	X
Prosartes trachycarpa	Rough-fruited Fairybells	none	endangered	Yes		Fire Dependent Forest	X
Pyrola minor	Small Shinleaf	none	special concern			Fire Dependent Forest, Forest Acid Peatland, Forested Rich Peatland	X
Ranunculus lapponicus	Lapland Buttercup	none	special concern			Forested Rich Peatland	X
Rubus chamaemorus	Cloudberry	none	threatened	Yes		Forest Acid Peatland	X
Rubus semisetosus	Swamp Blackberry	none	threatened	Yes		Forested Rich Peatland	X
Shepherdia canadensis	Soapberry	none	special concern			Fire Dependent Forest	X

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Trichophorum clintonii	Clinton's Bulrush	none	threatened			Fire Dependent Forest	X
Utricularia geminiscapa	Hidden-fruit Bladderwort	none	threatened	Yes		Non-Forested Rich Peatland, Non-Forested Acid Peatland	X
Waldsteinia fragarioides var. fragarioides	Barren Strawberry	none	special concern			Fire Dependent Forest, Mesic Hardwood Forest	X
Xyris montana	Montane Yellow-eyed Grass	none	special concern		Yes	Non-Forested Rich Peatland, Non-Forested Acid Peatland	X

Table 3-12: Terrestrial Wildlife Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need		Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Bird									
Accipiter gentilis	Northern Goshawk	none	special concern	Yes	Yes	Yes		Fire Dependent Forest, Mesic Hardwood Forest	X
Aegolius funereus	Boreal Owl	none	special concern	Yes		Yes		Fire Dependent Forest, Mesic Hardwood Forest, Forested Rich Peatland	X
Haliaeetus leucocephalus	Bald Eagle	Eagle Act	delisted		Yes			Fire Dependent Forest, Mesic Hardwood Forest	X
Cardellina Canadensis	Canada Warbler	Migratory Bird Act	none					not included in the MDNR rare species guide	X
Setophaga tigrina	Cape May Warbler	Migratory Bird Act	none					not included in the MDNR rare species guide	X
Coccothraustes vespertinus	Evening Grosbeak	Migratory Bird Act	none					not included in the MDNR rare species guide	X

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need		Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Insect									
Cicindela denikei	Laurentian Tiger Beetle	none	special concern			Yes		Fire Dependent Forest	X
Ophiogomphus anomalus	Extra-striped Snaketail	none	special concern			Yes		Fire Dependent Forest, Mesic Hardwood Forest	X
Plebejus idas nabokovi	Nabokov's Blue	none	special concern	Yes		Yes		Fire Dependent Forest	X
Somatochlora forcipata	Forcipate Emerald	none	special concern			Yes		Forested Rich Peatland, Non-Forested Rich Peatland	X
Mammal									
Canis lupus lycaon	Gray Wolf	threatened	delisted		Yes				X
Eptesicus fuscus	Big Brown Bat	none	special concern			Yes		Fire Dependent Forest, Mesic Hardwood Forest	X
Lynx canadensis	Canada Lynx	threatened	special concern			Yes			X
Myotis lucifugus	Little Brown Myotis	none	special concern	Yes		Yes	Yes	Mesic Hardwood Forest	X
Myotis septentrionalis	Northern Long-eared Bat	threatened	special concern			Yes		Fire Dependent Forest, Mesic Hardwood Forest	X
Phenacomys ungava	Eastern Heather Vole	none	special concern	Yes		Yes	Yes	Fire Dependent Forest, Non-Forested Rich Peatland, Non-Forested Acid Peatland	X
Sorex fumeus	Smoky Shrew	none	special concern			Yes		Fire Dependent Forest, Mesic Hardwood Forest, Forest Acid Peatland, Forested Rich Peatland	X
Synaptomys borealis	Northern Bog Lemming	none	special concern			Yes		Forest Acid Peatland, Forested Rich Peatland, Non-Forested Rich Peatland, Non-Forested Acid Peatland	no[1]
Reptile									
Emydoidea blandingii	Blanding's Turtle	none	threatened			Yes		Forested Rich Peatland	X

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Superior National Forest Indicator Species	Species of Greatest Conservation Need		Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Spider									
Habronattus calcaratus maddisoni	A Jumping Spider	none	special concern					Fire Dependent Forest	no[2]

Notes:

[1] Northern bog lemming need large tracts of suitable peatland (MDNR, 2019d) which are not present in the areas of potential ground disturbance. Therefore it is not expected that the Project would have an impact to the northern bog lemming.
[2] The only instance of the jumping spiders in Minnesota were at collection sites with cliffs capped by a layer of vegetation (MDNR, 2019d) which would not be present within the area of potential ground disturbance. Therefore, it is not expected that the Project would have an impact to the jumping spider.

Table 3-13: Aquatic Sensitive Species

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Bird								
Cygnus buccinator	Trumpeter Swan	none	special concern		Yes		Littoral Zone of Lake	
Sterna hirundo	Common Tern	none	threatened		Yes		Littoral Zone of Lake, Deep Water Zone of Lake	
Fish								
Acipenser fulvescens	Lake Sturgeon	none	special concern	Yes	Yes		Littoral Zone of Lake, Deep Water Zone of Lake	
Coregonus nipigon	Nipigon Cisco	none	special concern	Yes	Yes		Deep Water Zone of Lake	
Coregonus zenithicus	Shortjaw Cisco	none	special concern	Yes	Yes		Deep Water Zone of Lake	
Couesius plumbeus	Lake Chub	none	special concern		Yes		Littoral Zone of Lake, Small Rivers and Streams	
Ichthyomyzon fossor	Northern Brook Lamprey	none	special concern	Yes	Yes		Small Rivers and Streams	
Lepomis peltastes	Northern Sunfish	none	special concern		Yes		Littoral Zone of Lake	
Insect								
Boyeria grafiana	Ocellated Darner	none	special concern		Yes		Small Rivers and Streams	

Scientific Name	Common Name	Federal Status	State Status	Regional Forester Sensitive Species Status for Superior National Forest	Species of Greatest Conservation Need	Natural Heritage Information System Occurrence in Project Area	Minnesota Department of Natural Resources Rare Species Guide Habitats	Potentially Present in Areas of Potential Ground Disturbance
Goera stylata	A Caddisfly	none	threatened	Yes	Yes		Small Rivers and Streams	
Holocentropus glacialis	A Caddisfly	none	threatened				Littoral Zone of Lake	
Ochrotrichia spinosa	A Purse Casemaker Caddisfly	none	endangered		Yes		Small Rivers and Streams	
Ophiogomphus anomalus	Extra-striped Snaketail	none	special concern		Yes		Small Rivers and Streams	
Triaenodes flavescens	A Triaenode Caddisfly	none	special concern		Yes		Small Rivers and Streams	
Mussel								
Lasmigona compressa	Creek Heelsplitter	none	special concern	Yes	Yes		Small Rivers and Streams	
Reptile								
Emydoidea blandingii	Blanding's Turtle	none	threatened		Yes		Small Rivers and Streams	
Vascular Plant								
Callitriche heterophylla	Larger Water Starwort	none	threatened	Yes			Littoral Zone of Lake	
Caltha natans	Floating Marsh Marigold	none	endangered	Yes			Small Rivers and Streams	
Carex flava	Yellow Sedge	none	special concern				Small Rivers and Streams	
Cladium mariscoides	Twig Rush	none	special concern				Littoral Zone of Lake	
Crassula aquatica	Water Pygmyweed	none	threatened				Littoral Zone of Lake	
Elatine triandra	Three-stamened Waterwort	none	special concern				Littoral Zone of Lake	
Eleocharis robbinsii	Robbins' Spikerush	none	threatened				Littoral Zone of Lake	
Juncus subtilis	Slender Rush	none	endangered	Yes			Littoral Zone of Lake	
Littorella americana	American Shore Plantain	none	special concern				Littoral Zone of Lake	
Myriophyllum heterophyllum	Broadleaf Water Milfoil	none	special concern				Littoral Zone of Lake	
Najas gracillima	Slender Naiad	none	special concern				Littoral Zone of Lake	
Nymphaea leibergii	Small White Waterlily	none	threatened	Yes			Littoral Zone of Lake, Small Rivers and Streams	
Potamogeton oakesianus	Oakes' Pondweed	none	endangered	Yes			Littoral Zone of Lake	
Subularia aquatica ssp. americana	Awlwort	none	threatened	Yes			Littoral Zone of Lake	
Torreyochloa pallida	Torrey's Mannagrass	none	special concern				Littoral Zone of Lake, Small Rivers and Streams	
Utricularia resupinata	Lavender Bladderwort	none	threatened	Yes			Littoral Zone of Lake	

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3821 Table 3-14: Previous Intensive Archaeological Surveys within the Project Area

Author	Year	Report Title
Duluth Archaeology Center	2003	Phase I Archaeological Survey on T.H. 1 (S.P. 3802-18), Lake County, Minnesota
10,000 Lakes Archaeology	2012	Phase I Archaeological Survey of the Potential Maturi, Nokomis, Birch Lake Shaft Sites for Twin Metals Minnesota Inc., Lake and St. Louis Counties, Minnesota
106 Group	2012b	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Federal Lands, Lake County, Minnesota
106 Group	2012c	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeologic Field Activities on Non-Federal Lands, St. Louis and Lake Counties, Minnesota
106 Group	2013a	Phase I Archaeological Sruvey for Potential Twin Metals Minnesota Areas of Interest, St. Louis and Lake Counties, Minnesota
106 Group	2013b	Phase I Archaeological Survey for Twin Metals Minnesota 1-A Expansion Drill Program, Lake County, Minnesota
106 Group	2013c	Phase I Archaeological Sruvey for Twin Metals Minnesota 1-A Expansion Drill Program, Lake County, Minnesota
106 Group	2016	Phase I Archaeological Survey for Twin Metals Minnesota Well MN-512 Access Road Reroute Project, Lake County, Minnesota
106 Group	2017	Cultural Resources Study/Survey 2017 Season for Twin Metals Minnesota, St. Louis and Lake Counties, Minnesota
106 Group	2018a	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Federal Lands, Lake County, Minnesota
106 Group	2018b	Phase I Arcaheological Survey for Twin Metals Minnesota Hydrogeological Wells on Private Lands, St. Louis and Lake Counties, Minnesota
106 Group	2018c	Phase I Archaeological Survey for Twin Metals Minnesota Hydrogeological Wells on Non-Federal Public Lands, St. Louis and Lake Counties, Minnesota
106 Group	2018d	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Federal Land, Lake County, Minnesota
106 Group	2019a	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Private Land, St. Louis and Lake Counties, Minnesota

Author	Year	Report Title
106 Group	2019b	Phase I Archaeological Survey for Twin Metals Minnesota - 2018 Season on Non-Federal Public Lands, Lake County, Minnesota

Table 3-15: Background Criteria Pollutant Concentrations

Criteria Pollutant	Averaging Period	Meteorological Data Year	Background Concentration[(1)] ($\mu g/m^3$)
$PM_{2.5}$	Annual	2012-2016	4.0
$PM_{2.5}$	24-Hr Avg	2012-2016	12
PM_{10}	24-Hr Avg	2012-2016	70
SO_2	Annual	2012-2016	1.6
SO_2	24-Hr Avg	2012-2016	3.7
SO_2	3-Hr Avg	2012-2016	7.8
SO_2	1-Hr Avg	2012-2016	10.5
NO_2	Annual	2012-2016	5.6
NO_2	1-Hr Avg	2012-2016	45
CO	8-Hr Avg	2012-2016	600
CO	1-Hr Avg	2012-2016	800

Notes:

[1] Background ambient air concentrations are calculated design values based on data provided by the Minnesota Pollution Control Agency (MPCA) through its Criteria Pollutant Data Explorer website. PM2.5 data were obtained from Ely, Minnesota (0005). Using MPCA guidance for calculation of background concentrations, the PM2.5 24-hour background concentration is the average of the 98th percentile 24-hour values over three years. The PM2.5 annual background concentration is the average of the annual mean concentration over three years. PM10 data were obtained from Silver Bay (7640-1), near the North Shore Mining site. The PM10 24-hour background concentration is the high 2nd high value over the three-year period.

Given there are no background concentrations for gaseous pollutants in the upper Minnesota area, design values from 2015 - 2017 for Rosemount (0423) south of Minneapolis/St. Paul were used for nitrogen dioxide, sulfur dioxide, and carbon monoxide. While this site is in an urban area, the monitoring location is away from major roadways that could influence the results. The 1-hour SO2 background concentration is the three-year average of the 99th percentile of the annual distribution of daily maximum one-hour average concentrations, while the annual SO2 and NO2 concentrations are the average of the annual mean concentration

over three years. The 24-hour and 3-hour SO2 background concentrations are the second-high values over three years.

The 1-hour NO2 background concentration is the three-year average of the 98th percentile of the annual distribution of daily one-hour concentrations. The background CO concentrations are the high 2nd high value over the three-year period.

Abbreviations:

µg/m3 = micrograms per cubic meter
Avg = average
Hr = hour
PM = particulate matter

Table 3-16: Baseline Ambient Noise Levels

Measurement Location	Daytime Minimum (1-hour L_{eq} dBA)	Daytime Average (1-hour L_{eq} dBA)	Daytime Maximum (1-hour L_{eq} dBA)	Nighttime Minimum (1-hour L_{eq} dBA)	Nighttime Average (1-hour L_{eq} dBA)	Nighttime Maximum (1-hour L_{eq} dBA)
River Point Resort	<20	30	~50	<20	27	~50
Spruce Road	<20	30	~50	<20	27	~55
Birch West	~20	40	~60	<20	36	~60

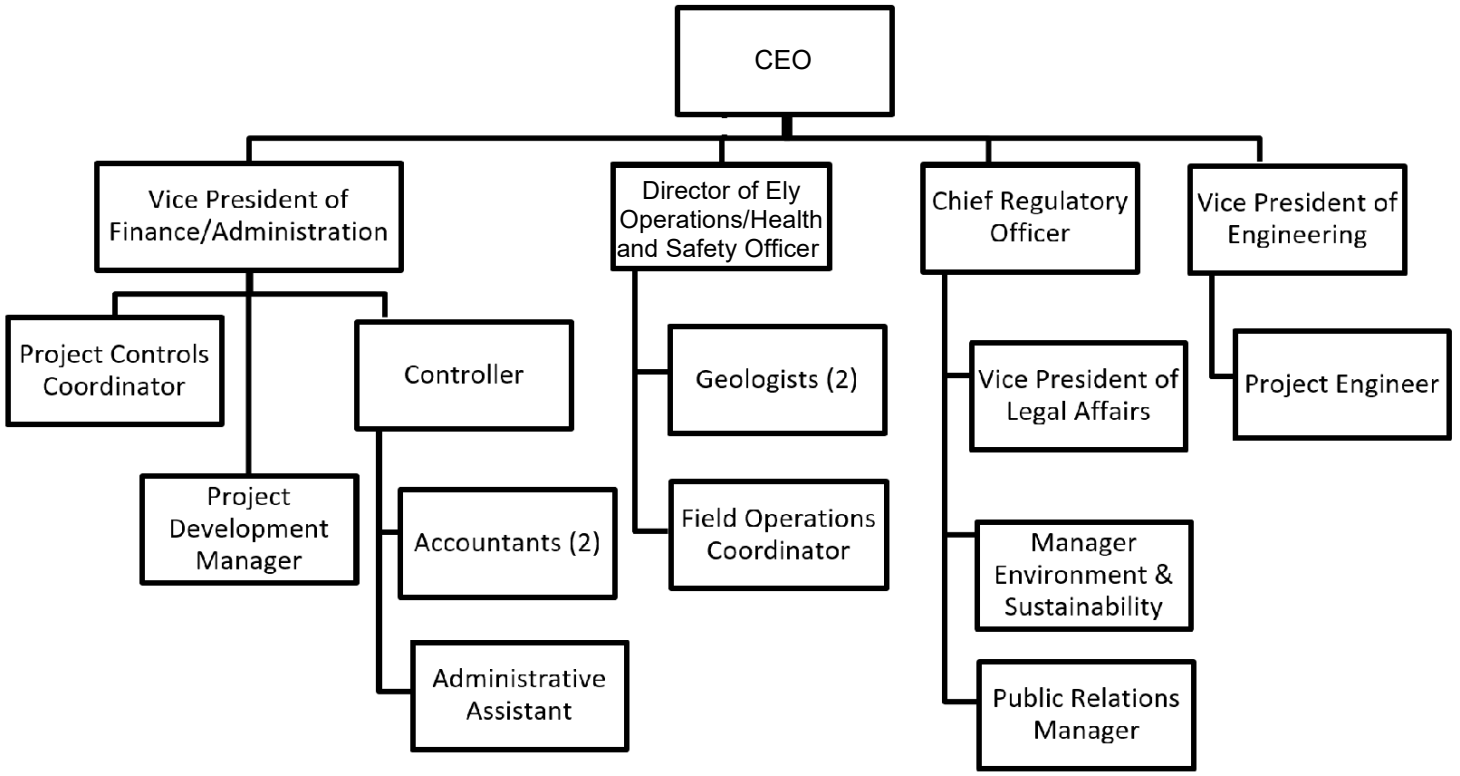
Abbreviations:

~ = approximately
< = Less than
dBA = adjusted decibels
L_{eq} = equivalent continuous sound level

Table 3-17: Existing and Forecast Annual Average Daily Traffic with and without Project Trips

Route	Description	Existing Annual Average Daily Traffic	Forecast (2040) Annual Average Daily Traffic	Project Generated Trips	Existing and Forecast (2040) Annual Average Daily Traffic with Project Generated Trips
TH 1	Between plant site and Ely, Minnesota	1,150	1,150	170	1,320
New Tomahawk Road	Between Babbitt and TH 1	130	130	0	130
CR 21	East of Salo Road and Babbitt, Minnesota	2,000	2,000	704	2,704

FIGURES

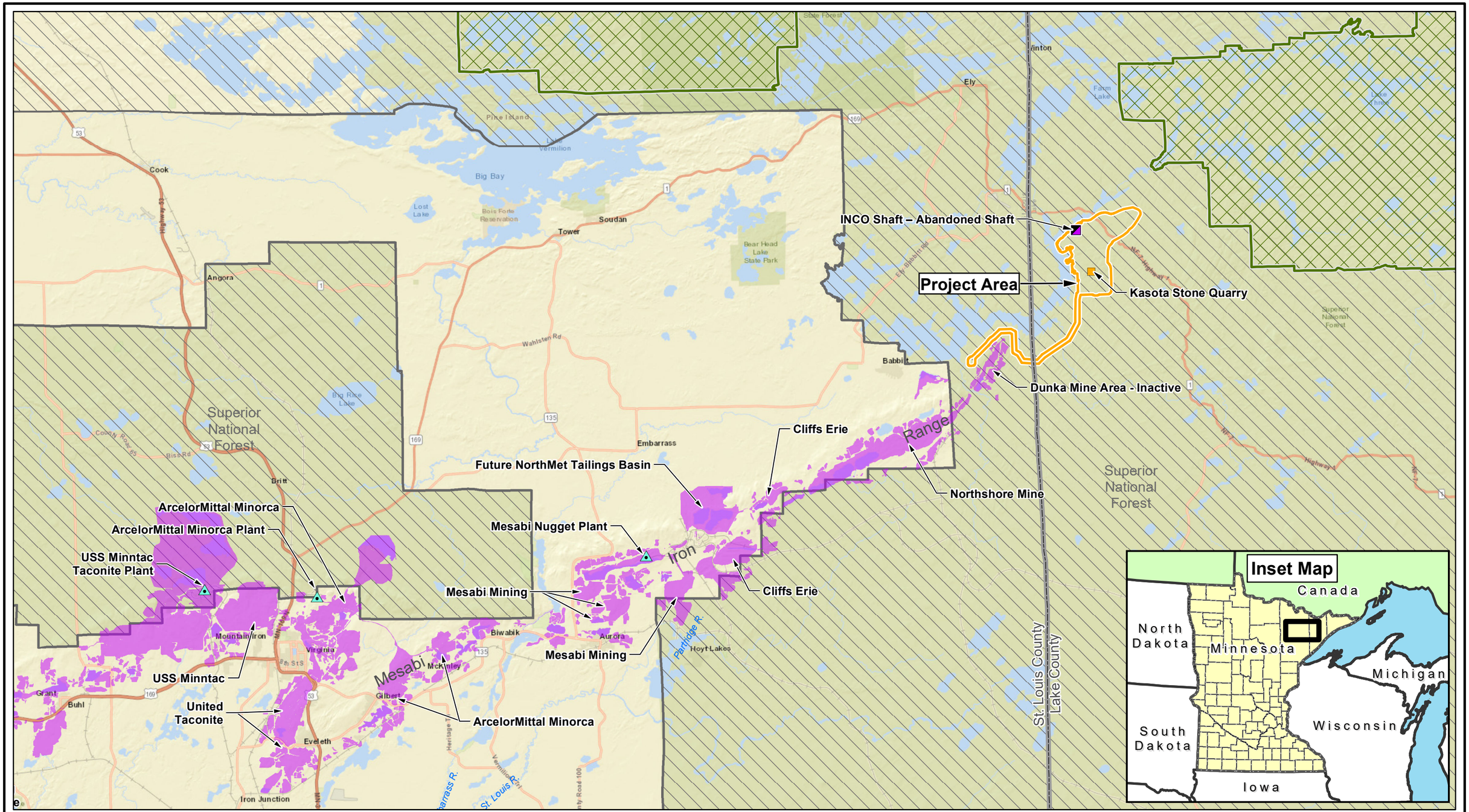


TWIN METALS MINNESOTA

FIGURE 1-1

ORGANIZATIONAL STRUCTURE

Scale: Not to Scale	Date: 09/19/2019



NOTES

1. Basemap from Esri and its data suppliers.
2. Boundary data from the MDNR.
3. Mining related data from MDNR Division of Lands and Minerals via email.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- INCO Shaft – Abandoned Shaft
- Kasota Stone Quarry
- Existing Taconite Plant
- County Boundary
- Project Area
- Superior National Forest Administrative Boundary (does not indicate surface ownership)
- Boundary Waters Canoe Area Wilderness
- Mesabi Range Mining Features (Existing Pits,Tailings Basins, Stockpiles and other Mine Features)

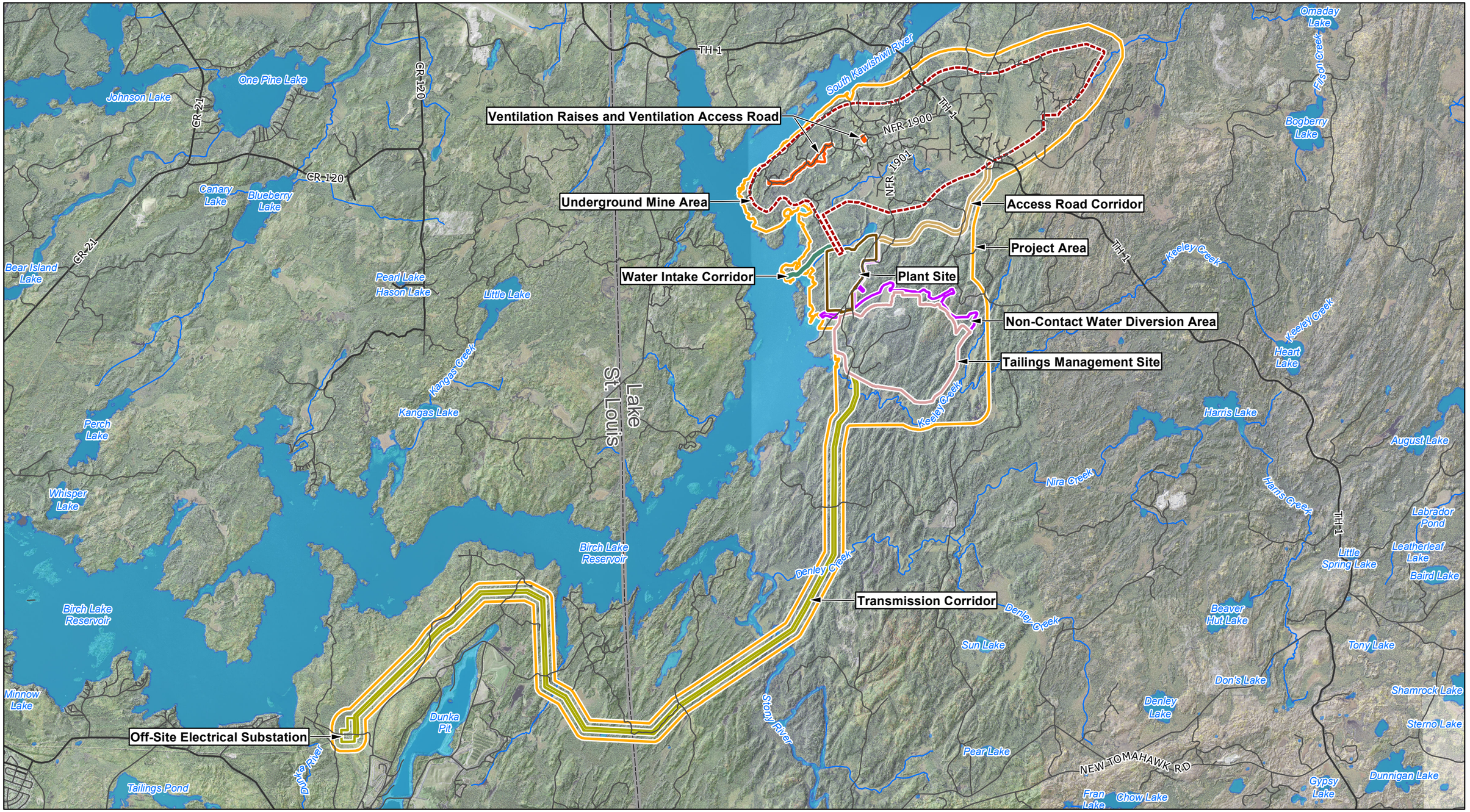
TWIN METALS MINNESOTA

FIGURE 2-1

PROJECT LOCATION

Scale: 0 2 4 Miles

Date: AUGUST 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

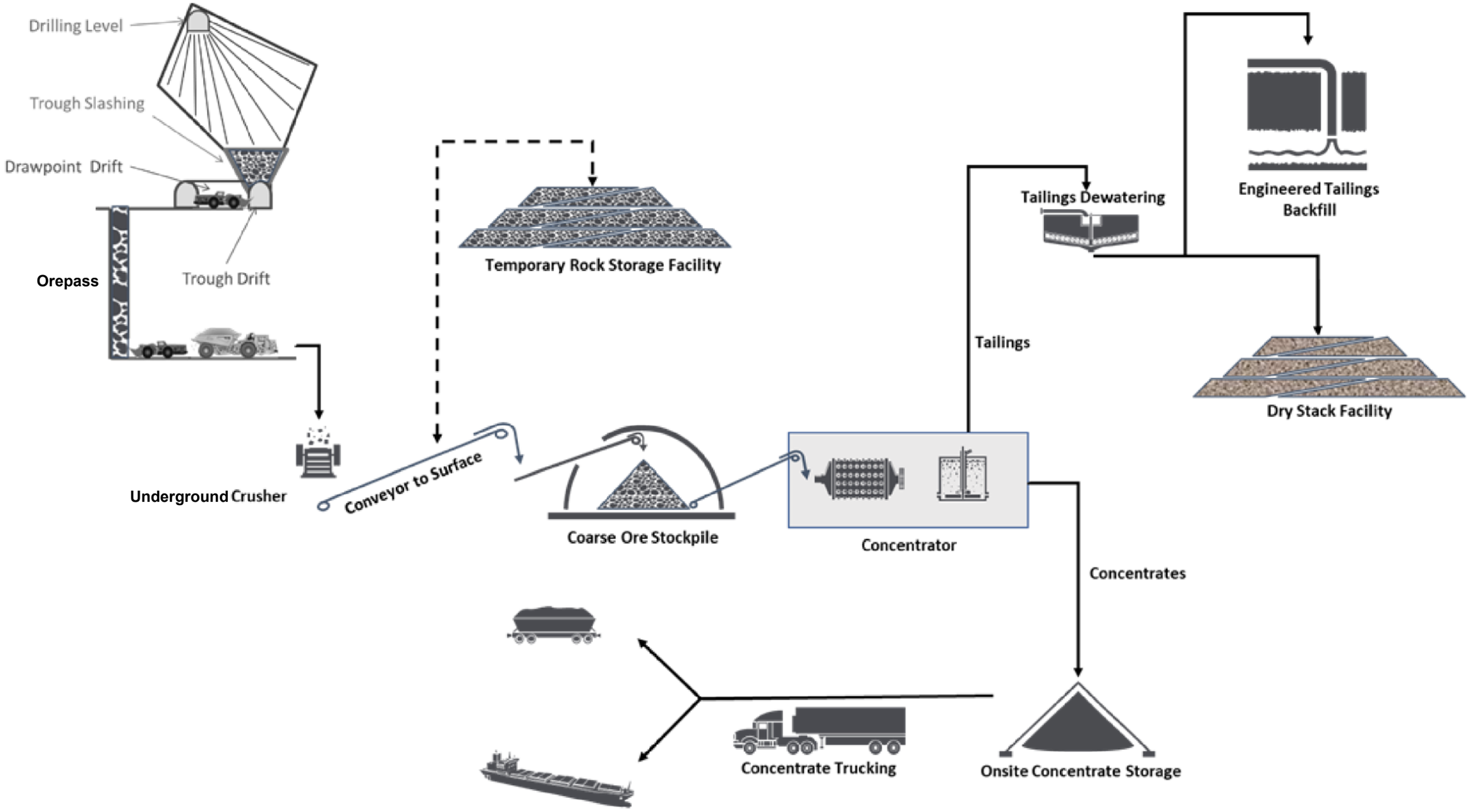
TWIN METALS MINNESOTA

FIGURE 2-2

GENERAL PROJECT LAYOUT

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

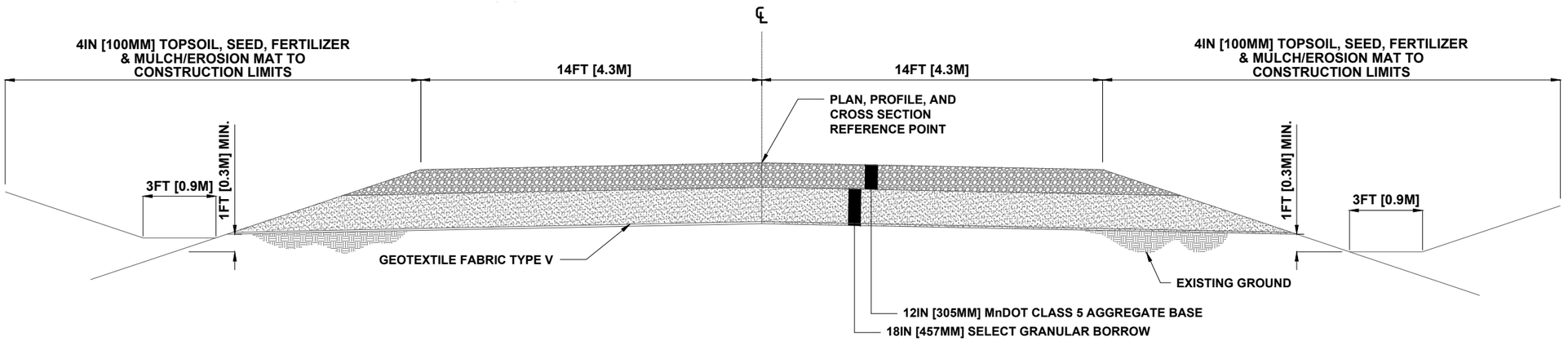


TWIN METALS MINNESOTA

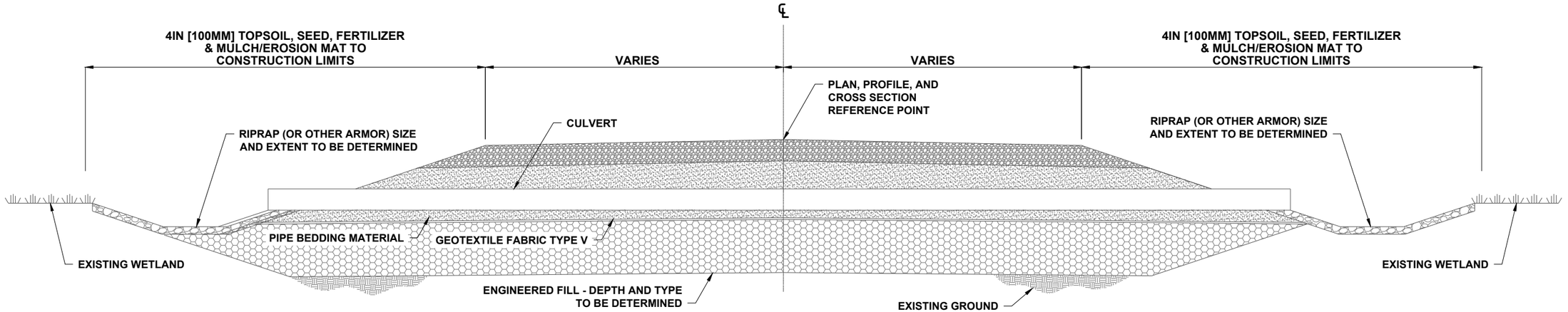
FIGURE 2-3

SIMPLIFIED PROJECT SCHEMATIC

Scale: Not to Scale	Date: 09/19/2019



TYPICAL SECTION



TYPICAL SECTION W/CULVERT

TWIN METALS MINNESOTA

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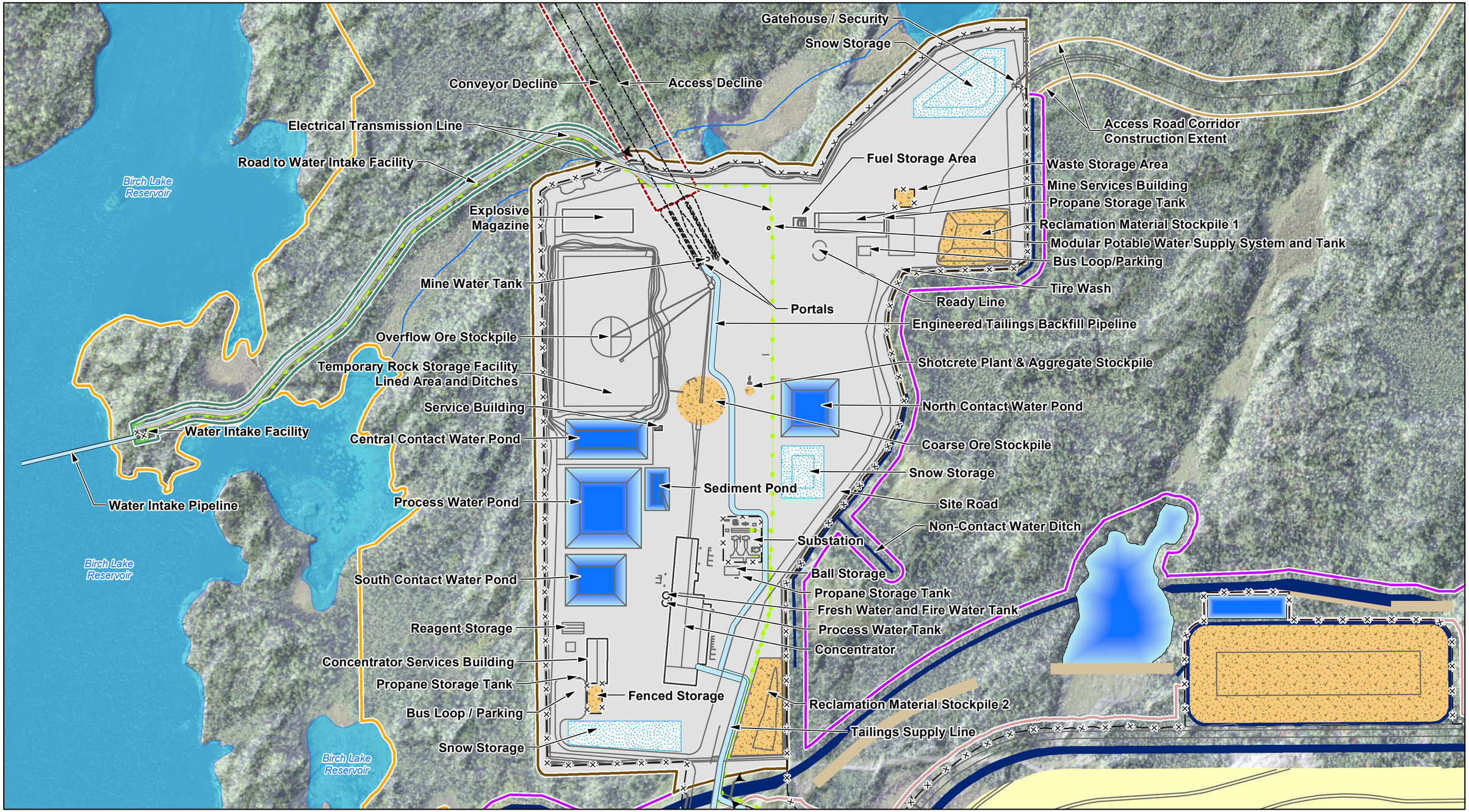
TWIN METALS MINNESOTA

FIGURE 2-4

ACCESS ROAD
TYPICAL SECTIONS

SCALE:	DATE: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Water Intake Corridor
- Access Road Corridor

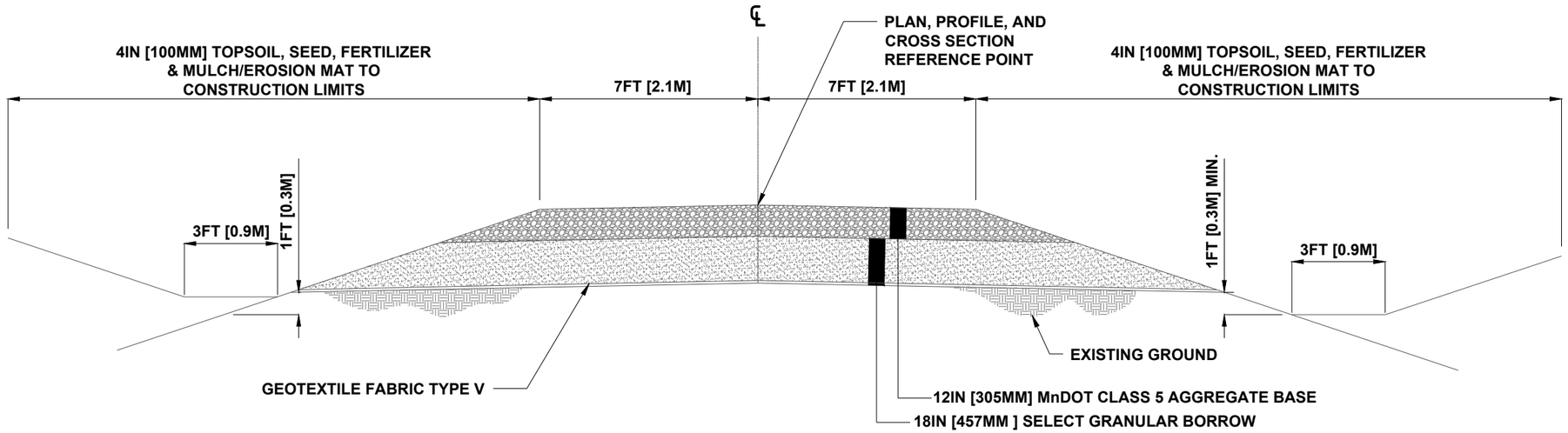
TWIN METALS MINNESOTA

FIGURE 2-5

PLANT SITE LAYOUT

Scale: 0 250 500 Feet

Date: SEPTEMBER 2019

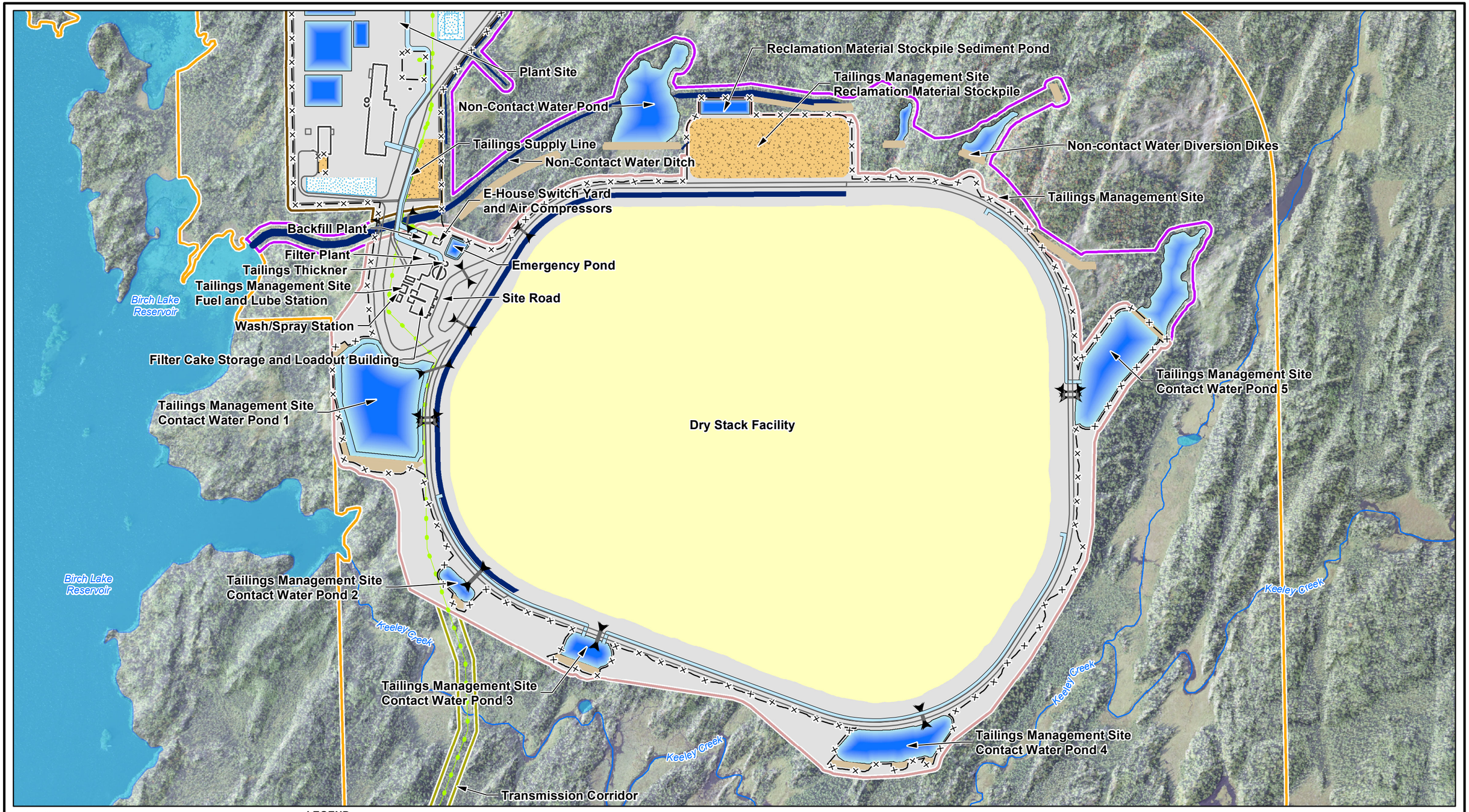


TYPICAL SECTION SINGLE LANE ROAD

TWIN METALS MINNESOTA

FIGURE 2-6
SINGLE LANE ROAD
TYPICAL SECTION

SCALE:	DATE: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facility
- Piping
- Dike; Berm
- Culvert
- Electrical Transmission Line
- Fence
- River/Stream
- Lake/Pond
- Project Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor

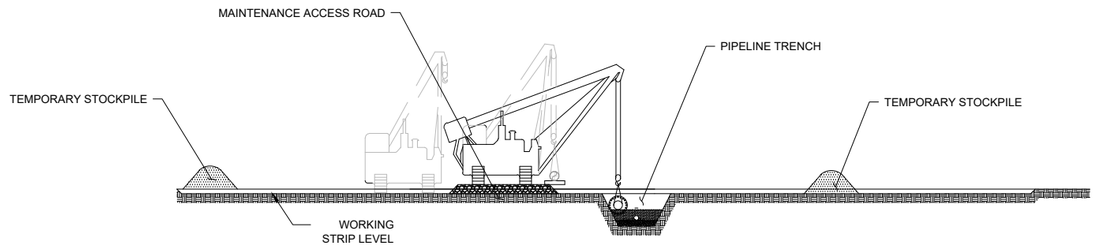
TWIN METALS MINNESOTA

FIGURE 2-7

TAILINGS MANAGEMENT SITE LAYOUT

Scale: 0 400 800 Feet

Date: SEPTEMBER 2019



SECTION: WATER INTAKE CORRIDOR (TYP.)

0 10 — 1:100 SCALE IN METERS

0 30 — 1:100 SCALE IN FEET

SECTION: WATER INTAKE CORRIDOR (TYP.)

0 4 — 1:40 SCALE IN METERS

0 12 — 1:40 SCALE IN FEET

NOTES:

1. CLEARING AND TEMPORARY DISTURBANCE LIMITS WILL BE CONTAINED WITHIN THE APPROXIMATE CONSTRUCTION LIMITS SHOWN. CLEARING AND TEMPORARY DISTURBANCE WILL VARY BY LOCATION AND WILL BE LIMITED TO THE EXTENT PRACTICABLE IN ORDER TO FACILITATE INFRASTRUCTURE CONSTRUCTION INCLUDING GRADING, TEMPORARY AND FUTURE ACCESS, AND MATERIAL STAGING AND LAYDOWN.

TWIN METALS MINNESOTA

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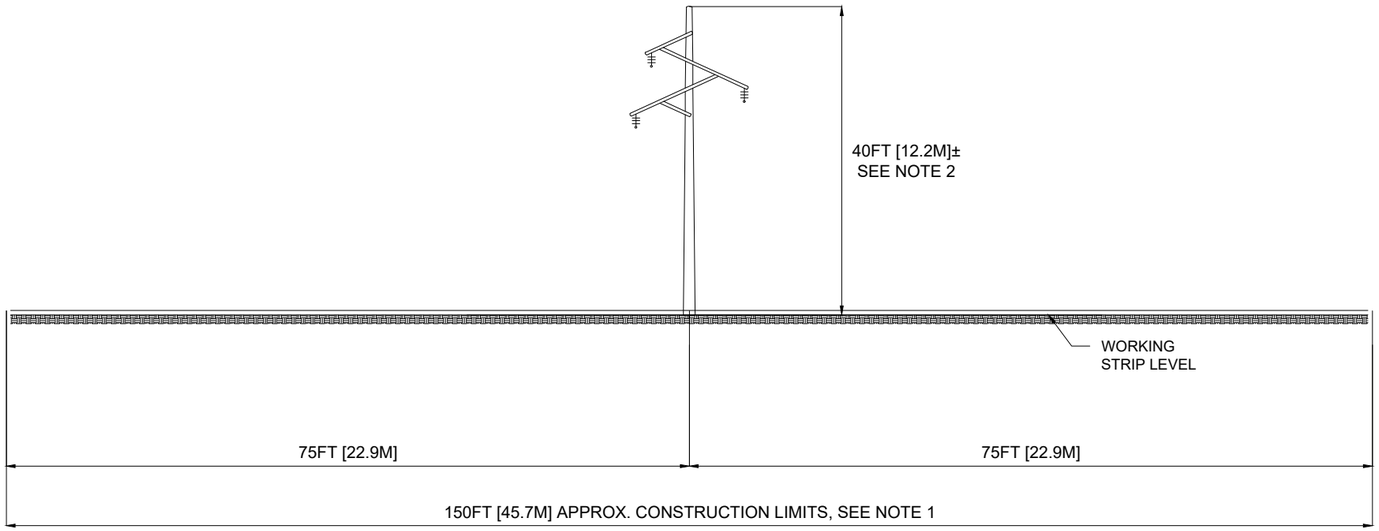
TWIN METALS MINNESOTA

FIGURE 2-8

WATER INTAKE AND CORRIDOR TYPICAL SECTIONS

SCALE:	DATE: SEPTEMBER 2019



SECTION: TRANSMISSION CORRIDOR (TYP.)

0 10 — 1:100 SCALE IN METERS

0 30 — 1:100 SCALE IN FEET

NOTES:

1. CLEARING AND TEMPORARY DISTURBANCE LIMITS WILL BE CONTAINED WITHIN THE APPROXIMATE CONSTRUCTION LIMITS SHOWN. CLEARING AND TEMPORARY DISTURBANCE WILL VARY BY LOCATION AND WILL BE LIMITED TO THE EXTENT PRACTICABLE IN ORDER TO FACILITATE INFRASTRUCTURE CONSTRUCTION INCLUDING GRADING, TEMPORARY AND FUTURE ACCESS, AND MATERIAL STAGING AND LAYDOWN.

2. THE NUMBER AND HEIGHT OF POWER POLES WILL VARY BASED ON THE VOLTAGE SELECTED DURING FUTURE PROJECT DEVELOPMENT.

TWIN METALS MINNESOTA

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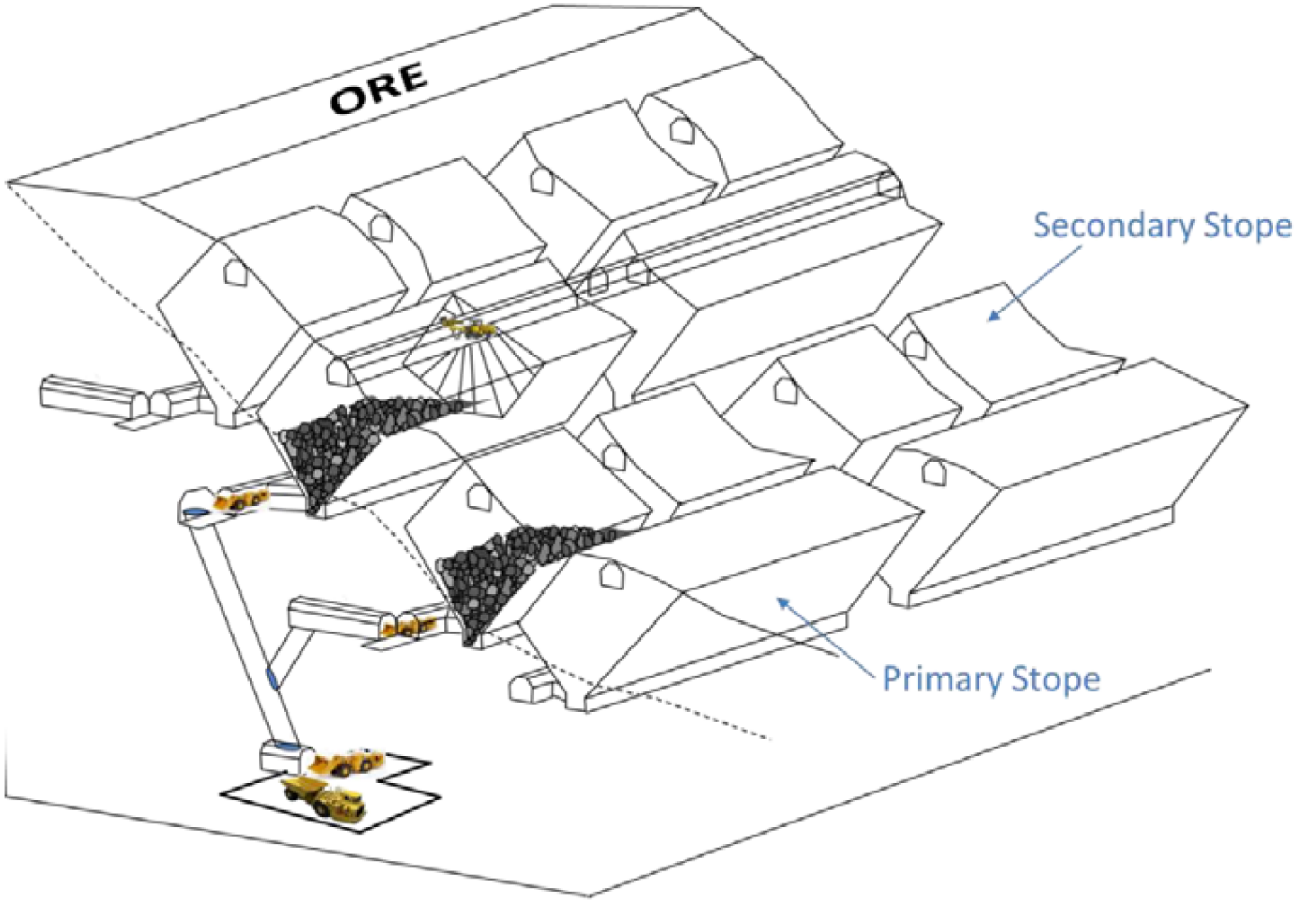
TWIN METALS MINNESOTA

FIGURE 2-9

TRANSMISSION CORRIDOR
TYPICAL SECTION

SCALE:	DATE: SEPTEMBER 2019

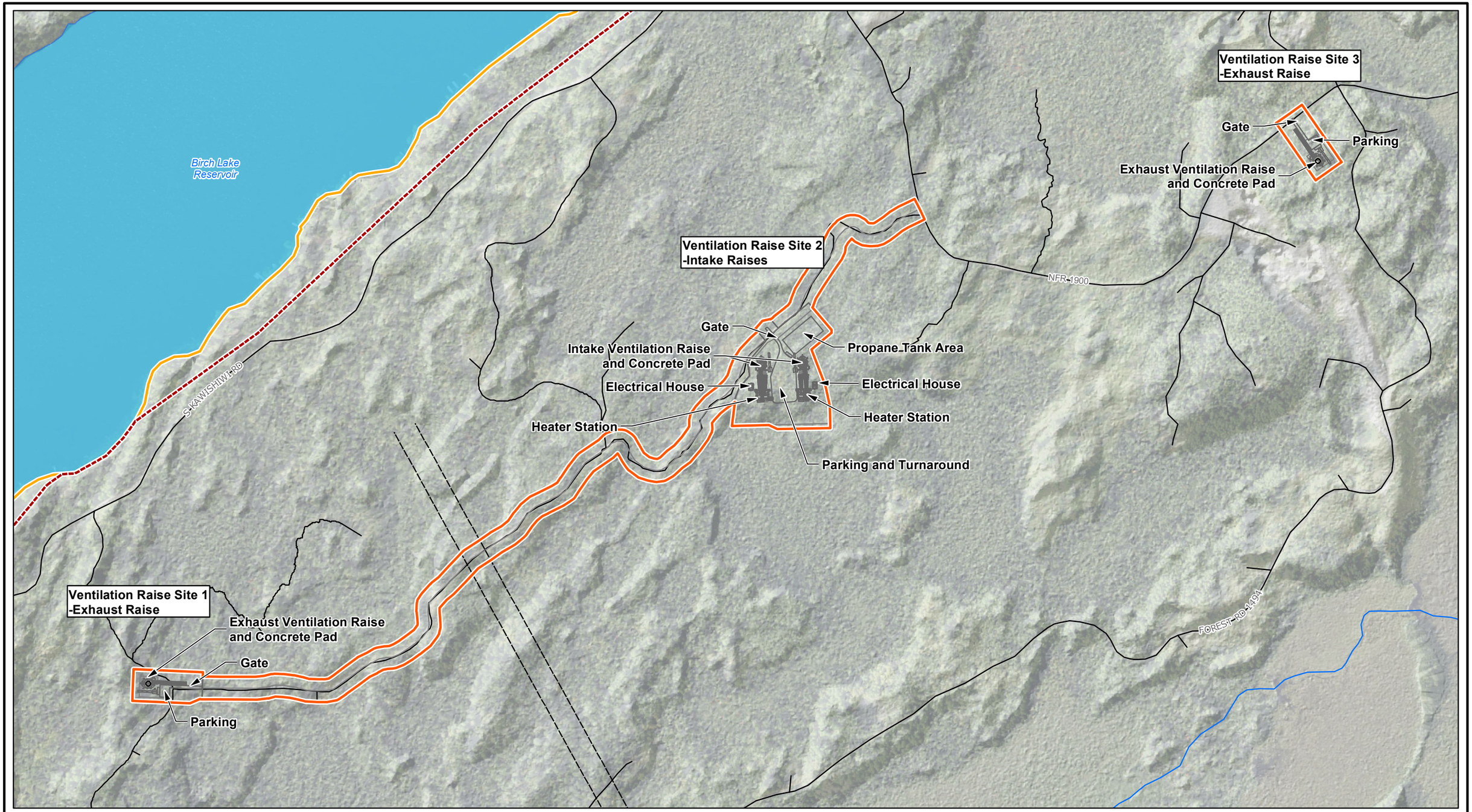


TWIN METALS MINNESOTA

FIGURE 2-10

MINING METHOD SCHEMATIC

Scale: Not to Scale	Date: 09/24/2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Digital elevation model hillshade downloaded from MnTopo.
3. Hydrographic data from Minnesota Department of Natural Resources.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facilities
- Decline
- Secondary Road
- River/Stream
- Lake/Pond
- Ventilation Raises and Ventilation Raise Access Road
- Underground Mine Area
- Project Area

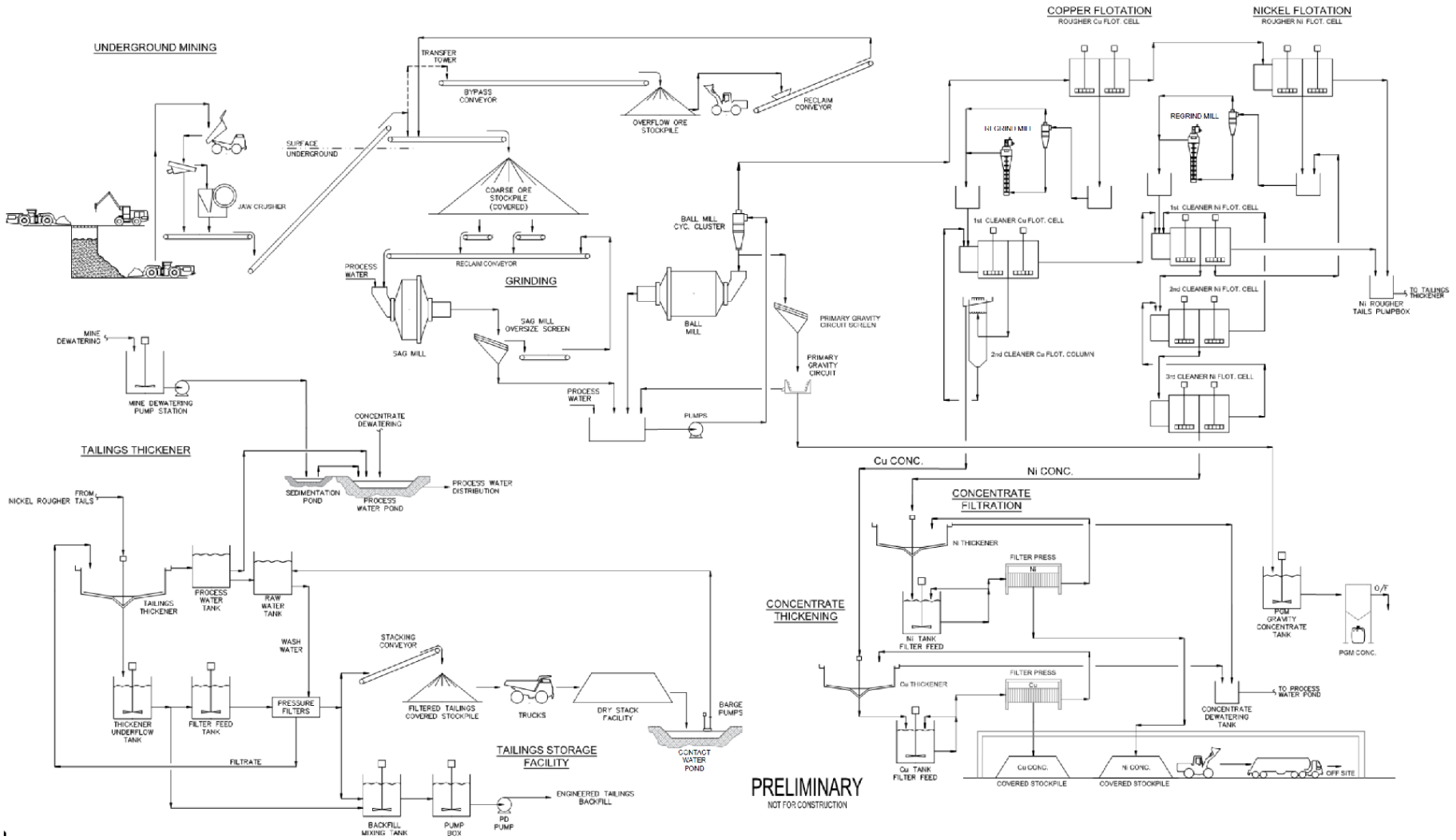
TWIN METALS MINNESOTA

FIGURE 2-11

VENTILATION RAISE LAYOUTS

Scale: 0 200 400 Feet

Date: SEPTEMBER 2019

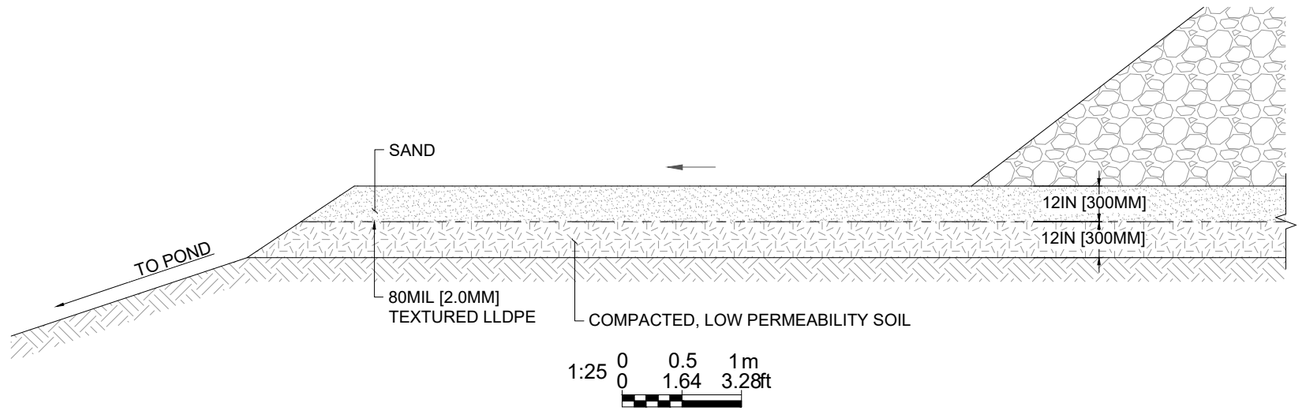


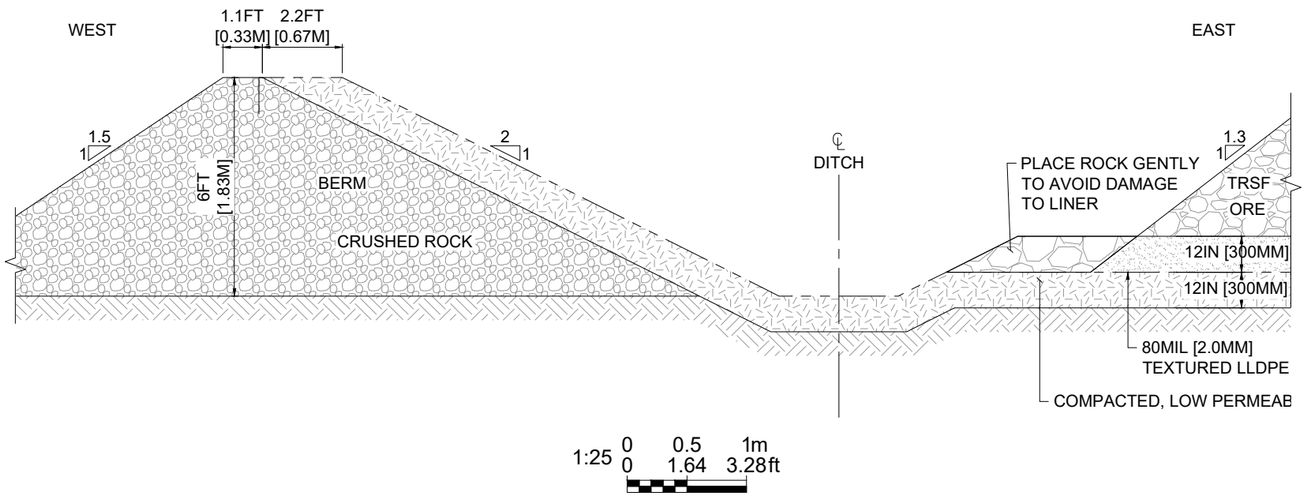
TWIN METALS MINNESOTA

FIGURE 2-12

OVERALL PROCESS FLOW DIAGRAM

Scale: Not to Scale	Date: 09/23/2019





TWIN METALS MINNESOTA

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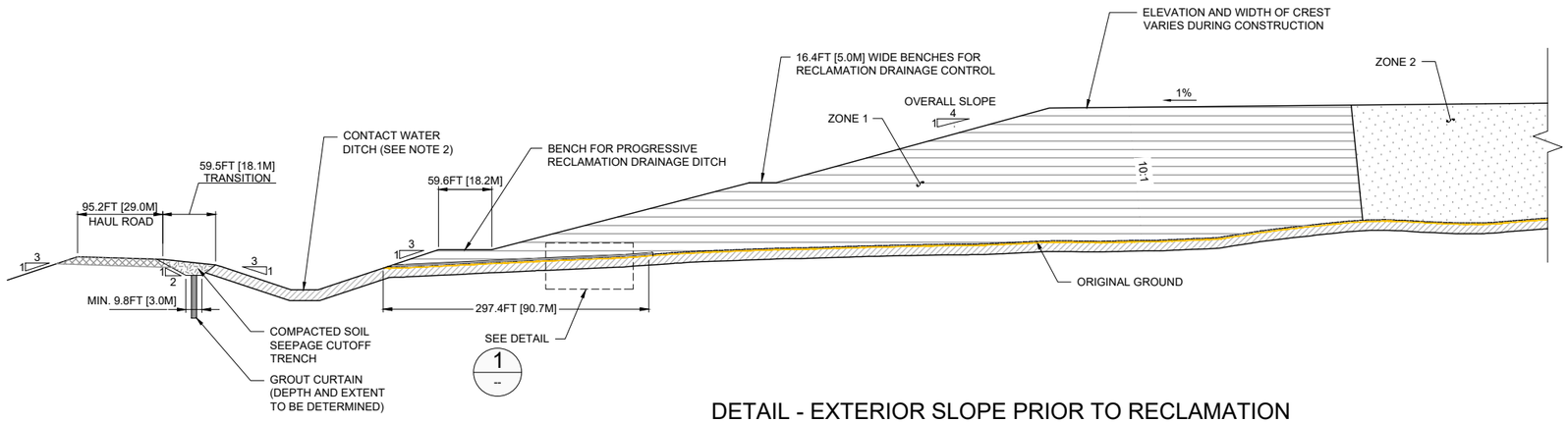
FIGURE 2-13

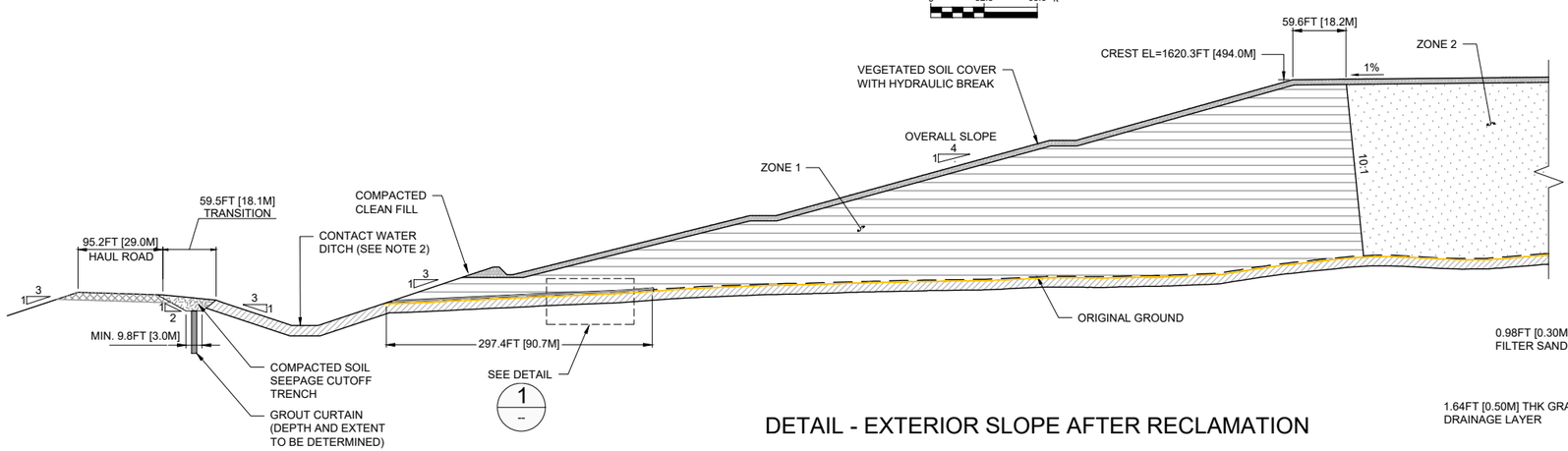
TEMPORARY ROCK STORAGE FACILITY SECTIONS

SCALE:	DATE: SEPTEMBER 2019



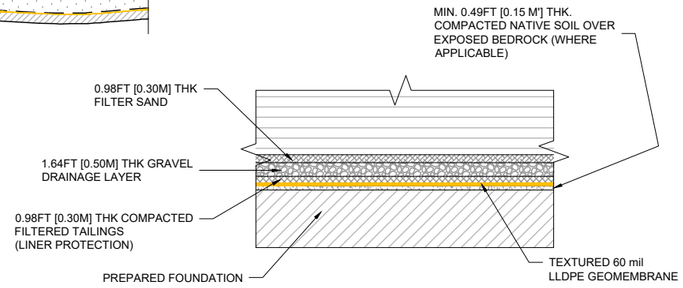
DETAIL - EXTERIOR SLOPE PRIOR TO RECLAMATION

1:1000 0 10 20 m
0 32.8 65.6 ft



DETAIL - EXTERIOR SLOPE AFTER RECLAMATION

1:1000 0 10 20 m
0 32.8 65.6 ft



1 BLANKET TOE DRAIN DETAIL
-

1:200 0 2.0 4.0 m
0 6.6 13.1 ft

LEGEND:

- ORIGINAL GROUND (20160426)
- PREPARED SURFACE
- ZONE 1 DENSELY COMPACTED TAILINGS (STRUCTURAL SHELL)
- ZONE 2 MODERATELY COMPACTED TAILINGS (NON-STRUCTURAL)
- SAND FILTER
- GRAVEL BLANKET TOE DRAIN
- COMPACTED ROAD FILL
- DRAIN SAND
- 60 mil LLDPE GEOMEMBRANE
- SOIL COVER
- COMPACTED SOIL SEEPAGE CUTOFF TRENCH
- GROUT CURTAIN
- COMPACTED CLEAN FILL

NOTES:

1. ORIGINAL GROUND SURVEY PROVIDED BY TWIN METALS MINNESOTA, RECEIVED ON APRIL 26, 2016.
2. SEEPAGE CUTOFF SURFACE WILL HAVE GRASS VEGETATION IN SOME LOCATIONS, RIPRAP ARMOUR IN OTHERS AND EXPOSED BEDROCK IN OTHERS.

TWIN METALS MINNESOTA

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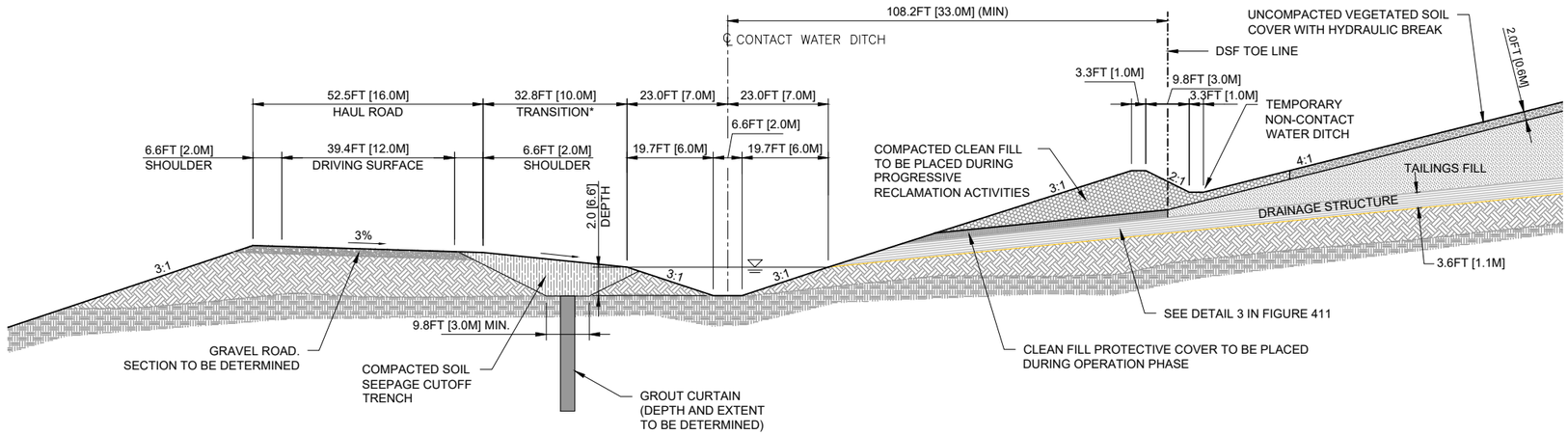
FIGURE 2-14
TYPICAL CROSS SECTION
OF EXTERIOR SLOPE

SCALE:	DATE: SEPTEMBER 2019



*NOTE ABOUT TRANSITION SLOPE:
SLOPES THROUGH TRANSITION WILL VARY DEPENDING ON MATERIAL AS FOLLOWS:

1) FOR FILL CONDITION: FROM 3% TO 3(H):1(V)
2) FOR CUT CONDITION (THROUGH OVERBURDEN): FROM 3% TO 3(H):1(V)
3) FOR CUT CONDITION (THROUGH BEDROCK): FROM 3% TO 1(H):1(V)

TYPICAL PERIMETER CONTACT WATER DITCH DETAIL

SCALE = 1:400

LEGEND:

- COMPACTED CLEAN FILL
- CLEAN FILL PROTECTIVE COVER
- DRAINAGE COVER
- COMPACTED FILTERED TAILINGS
- ROAD GRAVEL SURFACE
- COMPACTED LOW PERMEABILITY SOIL
- GROUT CURTAIN
- SUITABLE FOUNDATION (PREPARED OVERBURDEN OR COMPACTED FILL)
- BEDROCK
- 60 mil LLDPE Geomembrane

TWIN METALS MINNESOTA

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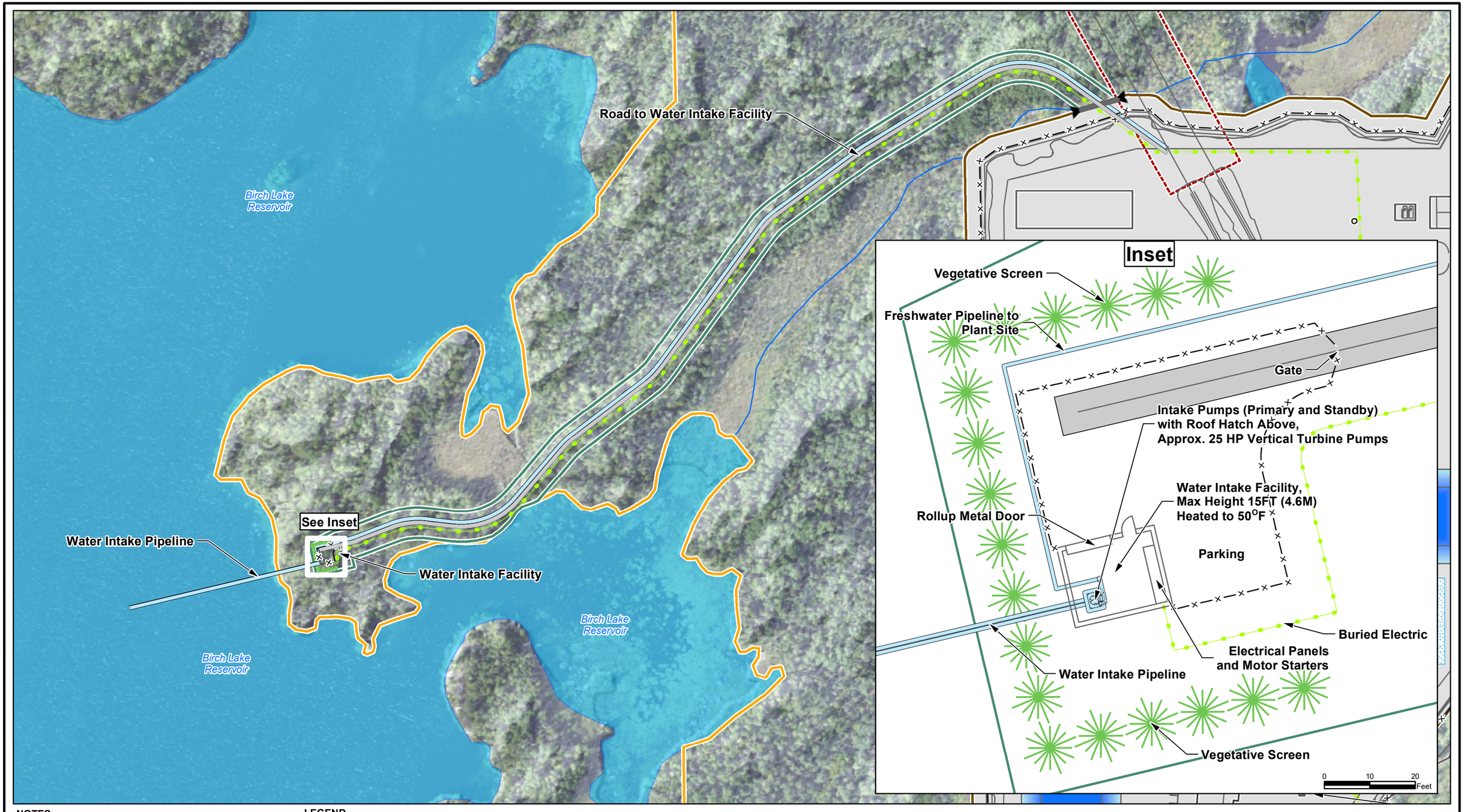
TWIN METALS MINNESOTA

FIGURE 2-15
TYPICAL DITCH SECTION

SCALE:	DATE: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facilities
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Water Intake Corridor

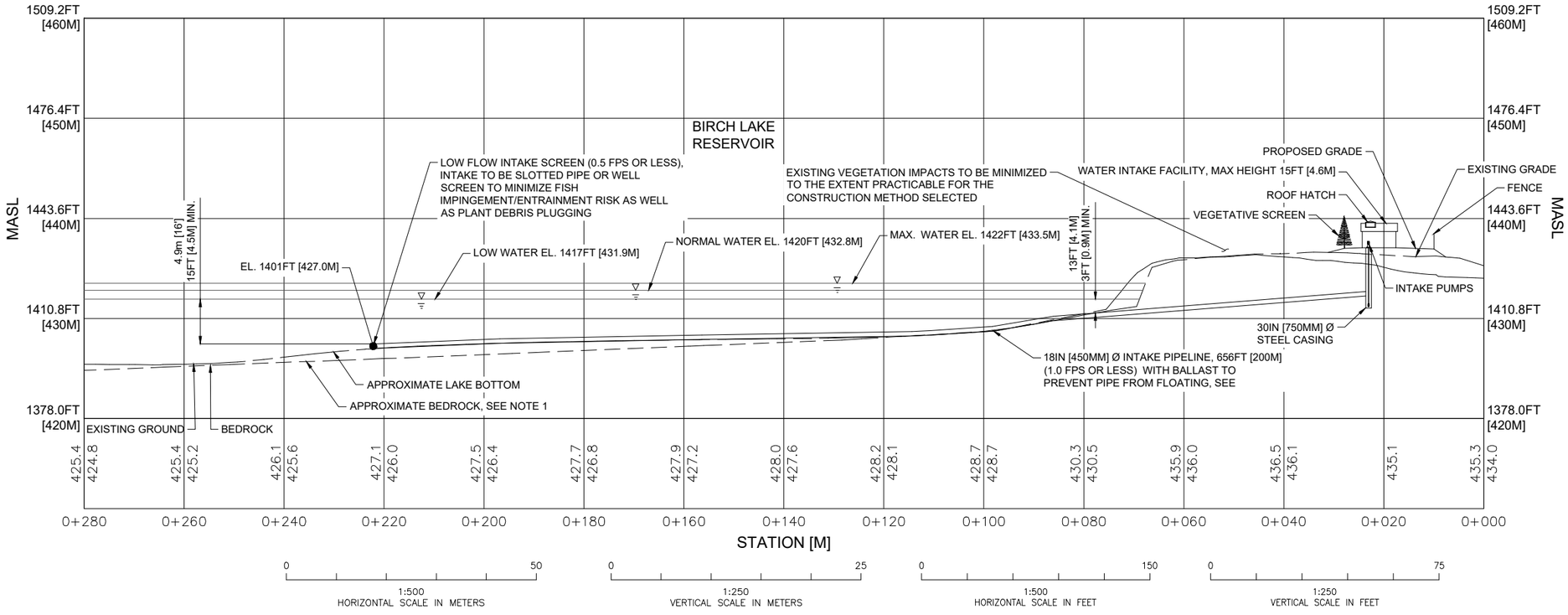
TWIN METALS MINNESOTA

FIGURE 2-16

WATER INTAKE FACILITY AND ACCESS ROAD PLAN AND GENERAL ARRANGEMENT

Scale: 0 150 300 Feet

Date: SEPTEMBER 2019



NOTES:

1. TOP OF BEDROCK ESTIMATES SHOWN IN THE PROFILES ARE BASED ON DATA FROM THE MINNESOTA GEOLOGICAL SURVEY (OFR2016-04) DOWNLOADED FEBRUARY 12, 2018.

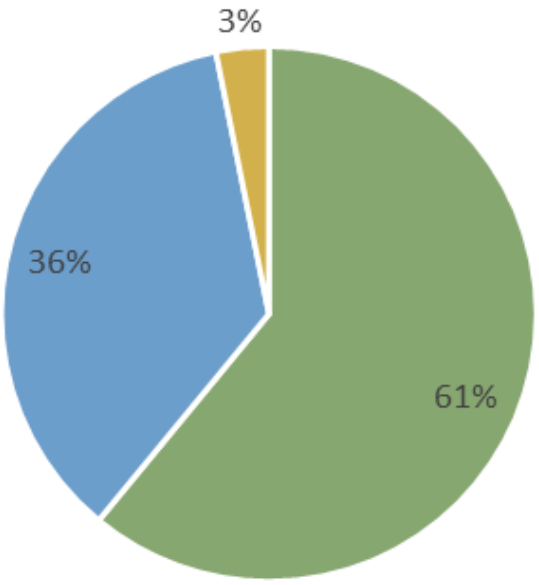
TWIN METALS MINNESOTA

FIGURE 2-17

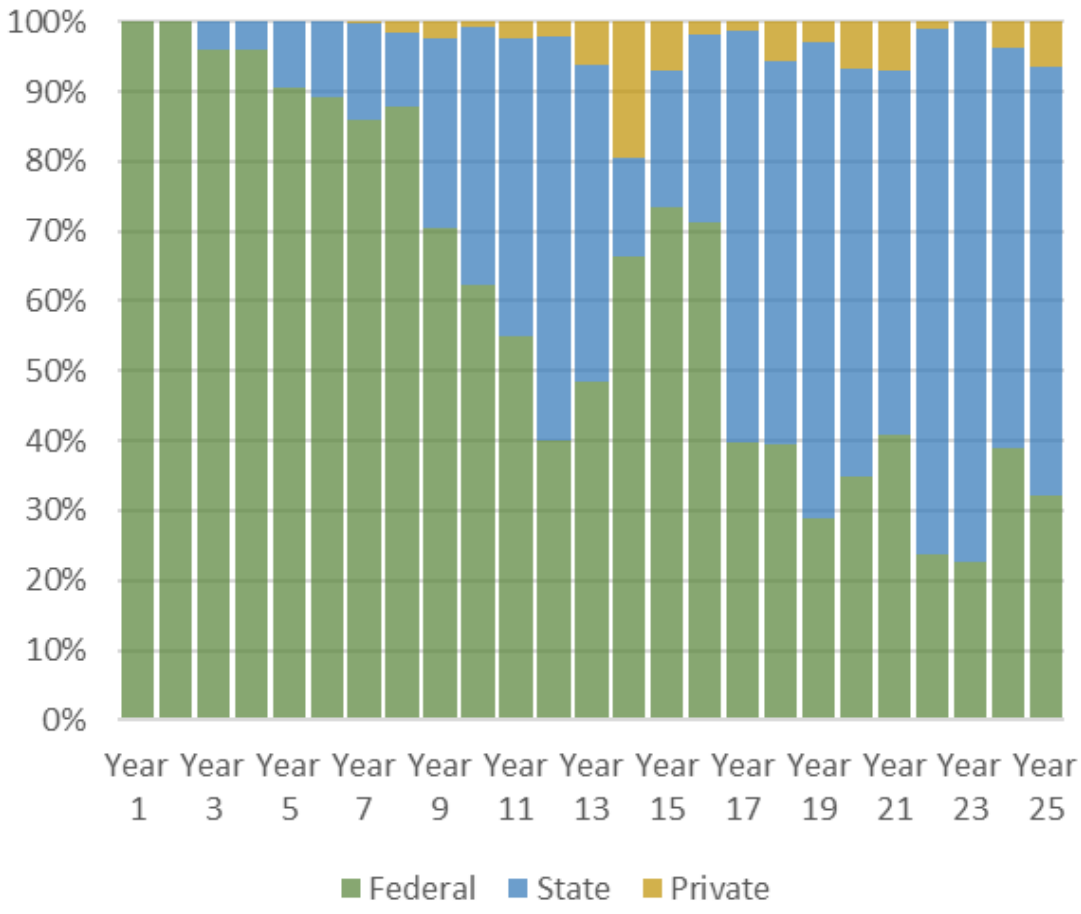
WATER INTAKE FACILITY
PLAN, PROFILE, SECTIONS AND DETAILS

SCALE: 0 187.5 375 750 FEET

DATE: AUGUST 2019



Mine Plan by Owner Type (25 Years)



Mine Plan by Lease Owner Type (Annual)

TWIN METALS MINNESOTA

FIGURE 2-18

MINE PLAN BY
LEASE OWNER TYPE

Scale: Not to Scale	Date: 09/24/2019

UNDERGROUND MINE DESIGN - PLAN VIEW

LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT
- INTAKE RAISE
- EXHAUST RAISE

TWIN METALS MINNESOTA

N

TWIN METALS MINNESOTA

FIGURE 2-19

UNDERGROUND MINE DESIGN - STAGES MINE DESIGN - PLAN VIEW

SCALE: 0 457200 FEET

DATE: SEPTEMBER 2019

LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT

TWIN METALS MINNESOTA

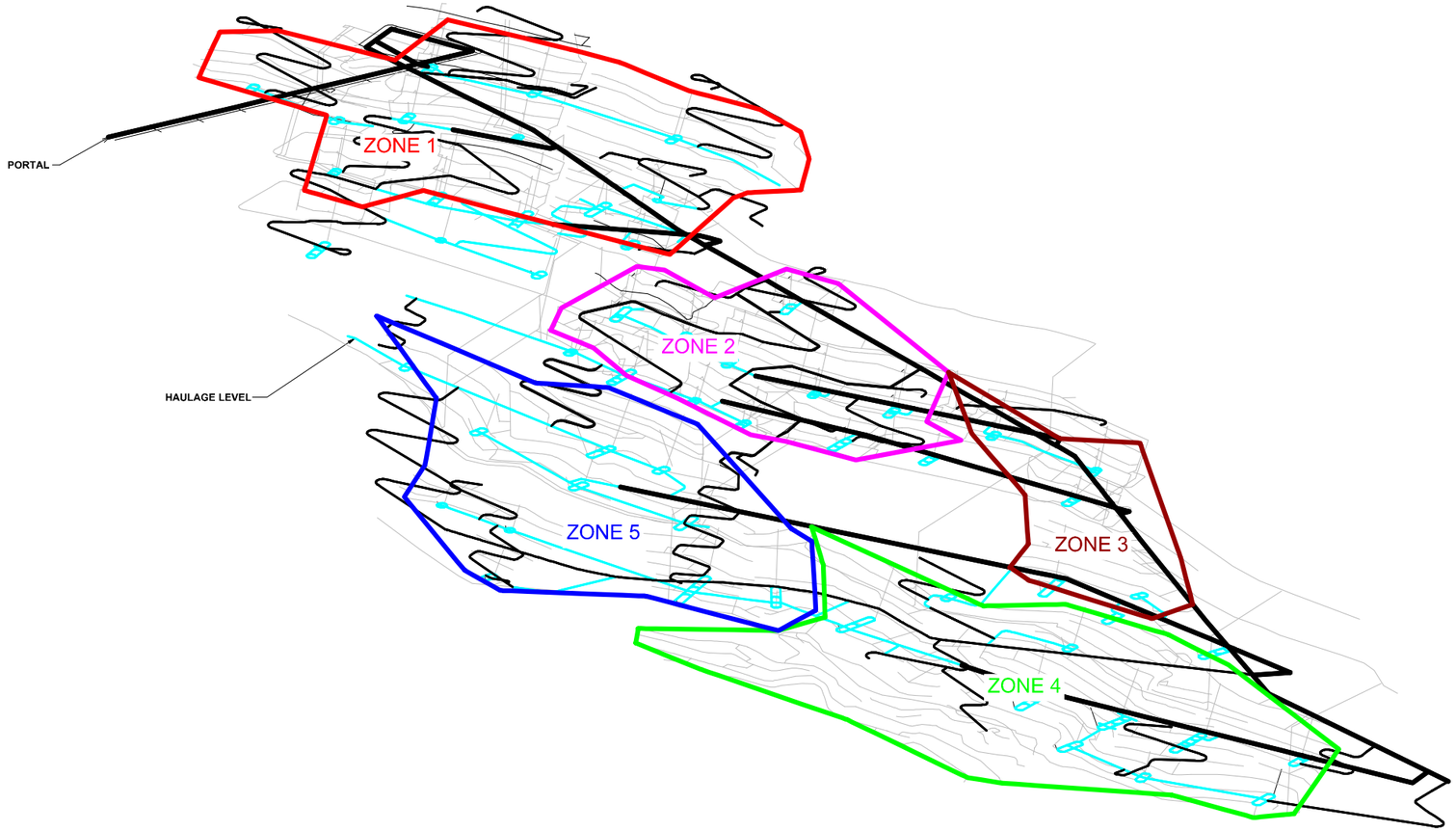
N

TWIN METALS MINNESOTA

FIGURE 2-20
UNDERGROUND MINE DESIGN -
STAGES FRONT VIEW - SECTION A

SCALE: 0 457200 FEET

DATE: SEPTEMBER 2019



LEGEND

- ZONE 1 BOUNDARY
- ZONE 2 BOUNDARY
- ZONE 3 BOUNDARY
- ZONE 4 BOUNDARY
- ZONE 5 BOUNDARY
- MINE RAMP
- HAULAGE LEVEL
- CONVEYOR DRIFT
- DRIFT

TWIN METALS MINNESOTA

N

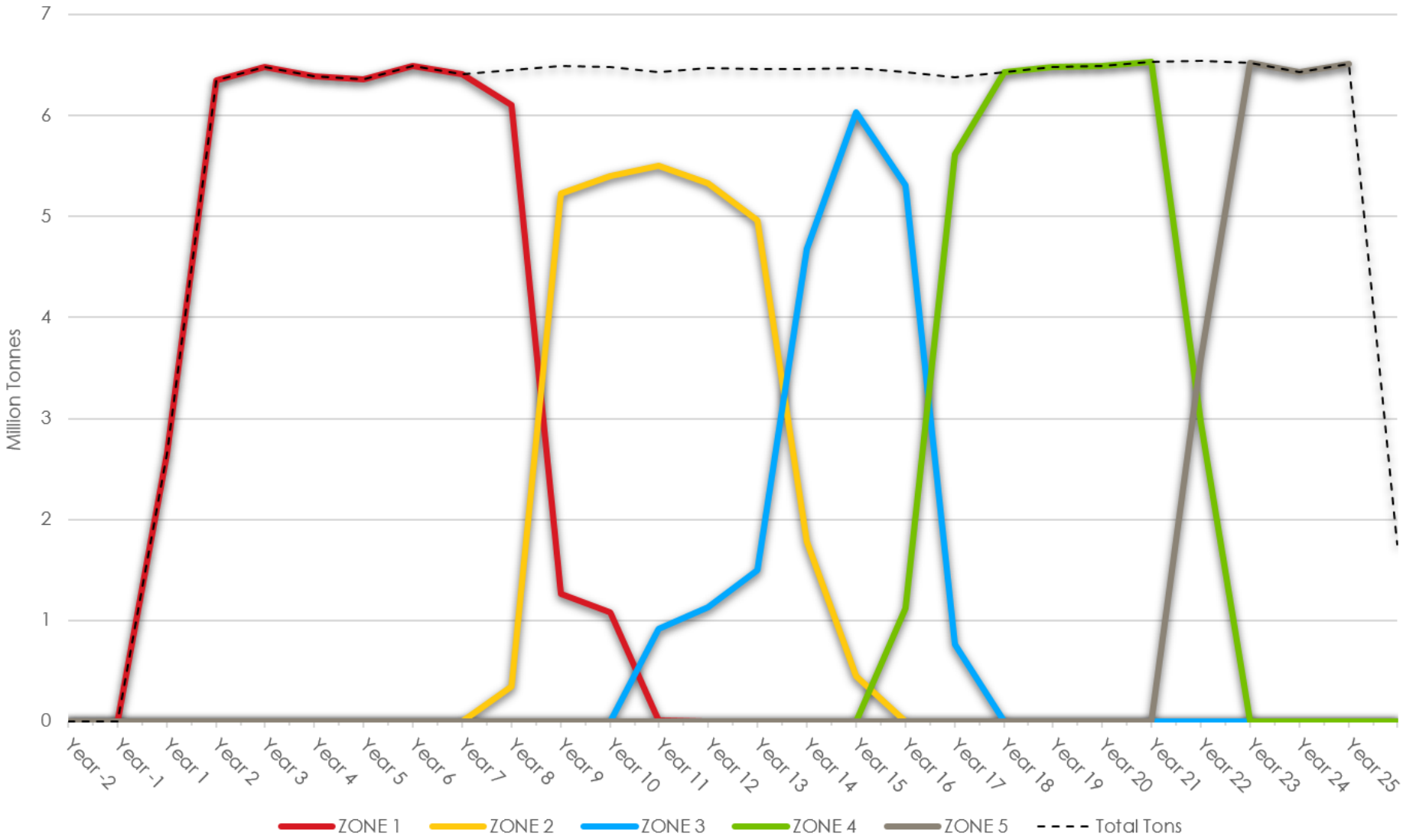
TWIN METALS MINNESOTA

FIGURE 2-21

UNDERGROUND MINE
DESIGN - STAGES ISO VIEW

SCALE: 0 457200 FEET

DATE: SEPTEMBER 2019

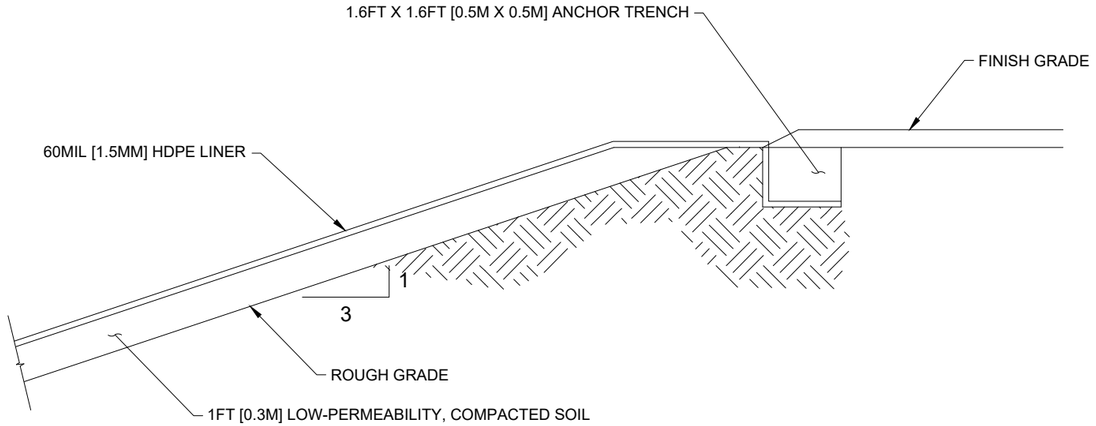


TWIN METALS MINNESOTA

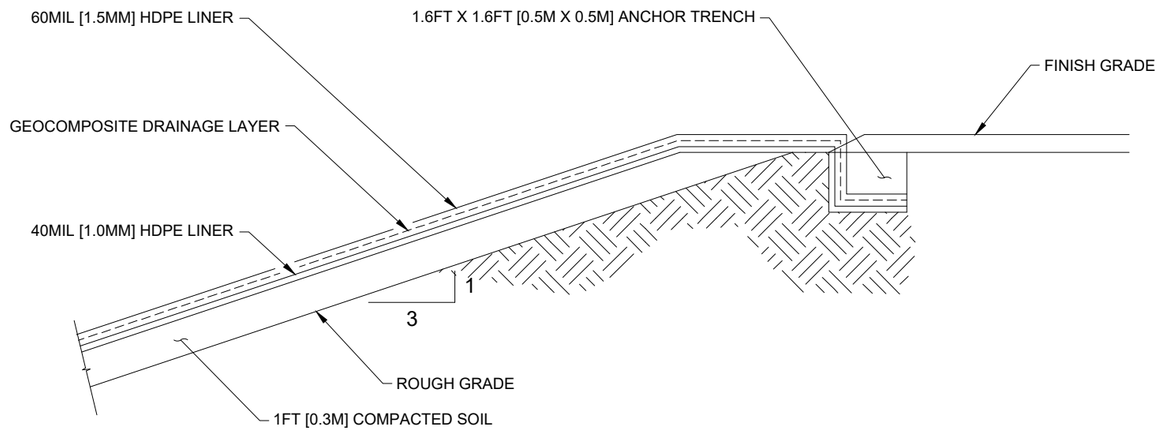
FIGURE 2-22

MINE PRODUCTION BY ZONE OVER TIME

Scale: Not to Scale	Date: 09/24/2019



TYPICAL CONTACT WATER POND LINER



TYPICAL PROCESS WATER POND LINER

NOTES:

1. THIS DRAWING SHOWS LINER REQUIREMENTS FOR THE CONTACT AND PROCESS WATER PONDS. CIVIL, MECHANICAL, AND PIPING ARE NOT SHOWN.

TWIN METALS MINNESOTA

N

TWIN METALS MINNESOTA

FIGURE 2- 23

PLANT SITE OPERATIONS SITE PONDS SECTIONS

SCALE:	DATE: SEPTEMBER 2019

Activity	Construction										Operations	
	Year -3		Year -2				Year -1				Year 1	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Construction												
Construction start	★											
Site Development & Access Roads												
Portal and Decline Development												
Mine & Mine Infrastructure												
Concentrator												
Tailings Dewatering Plant												
Dry Stack Facility												
Commissioning												
Stope Mining Begins									★			
Commissioning & Ramp-up												
Commerical Production												★

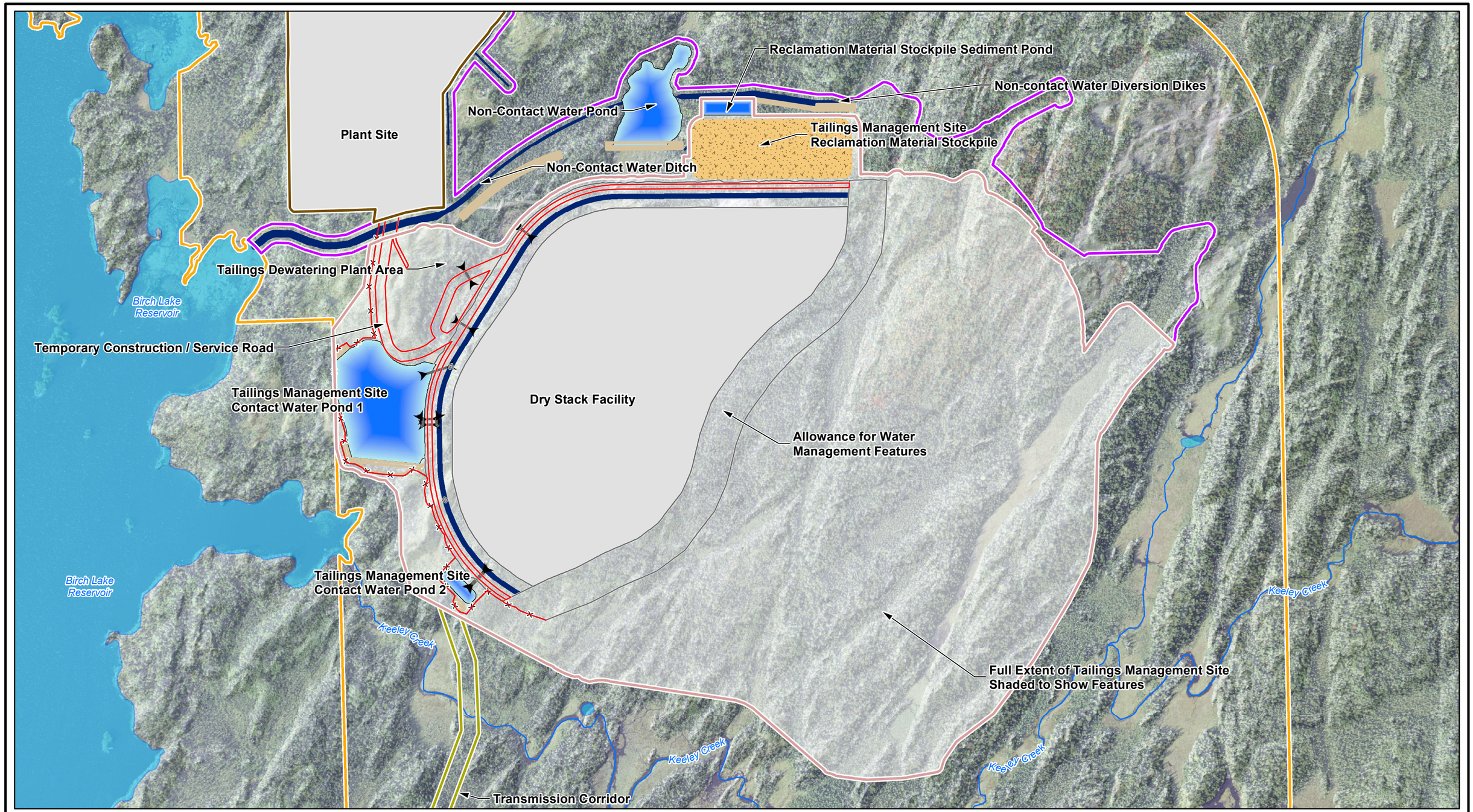
TWIN METALS MINNESOTA

TWIN METALS MINNESOTA

FIGURE 2-24

PROJECT CONSTRUCTION SCHEDULE

Scale: Not to Scale	Date: 09/19/2019



NOTES:

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from MDNR.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Temporary Facilities
- Dike; Berm; Embankment
- Facilities
- Culvert
- Fence
- River/Stream
- Lake/Pond
- Project Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor

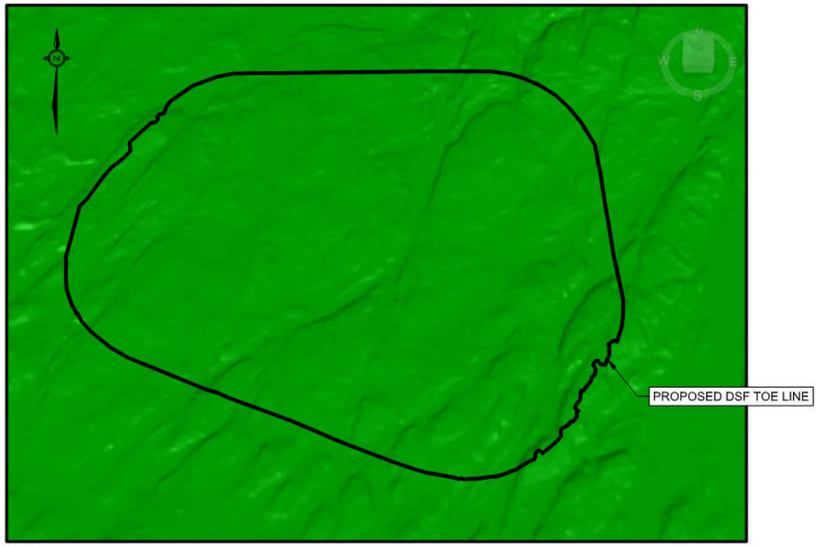
TWIN METALS MINNESOTA

FIGURE 2-25

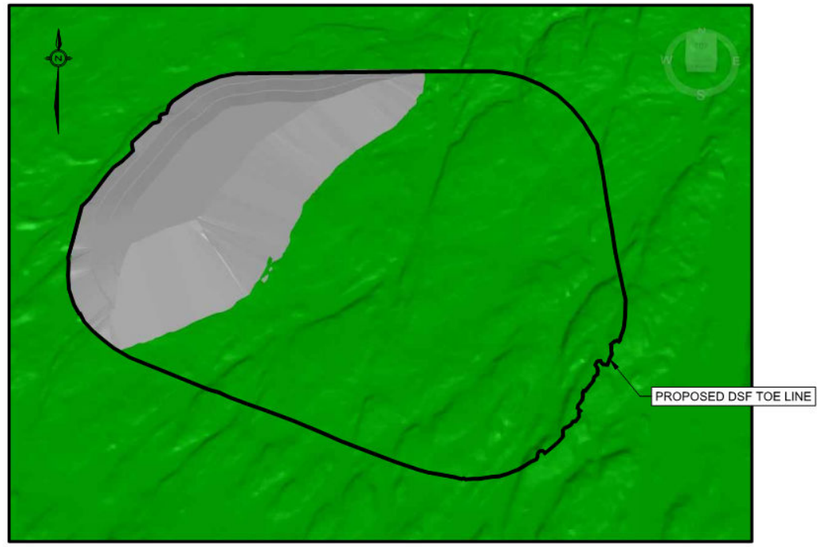
TAILINGS MANAGEMENT SITE
CONSTRUCTION PHASE

Scale: 0 400 800 Feet

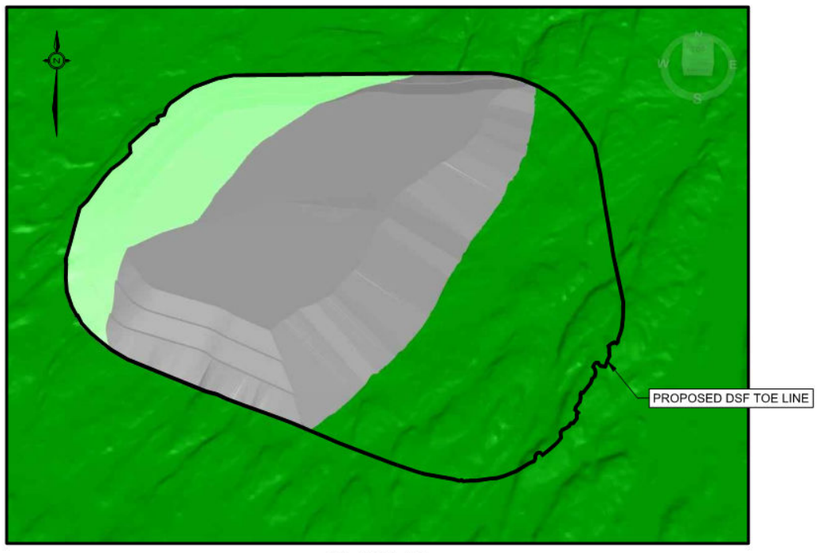
Date: SEPTEMBER 2019



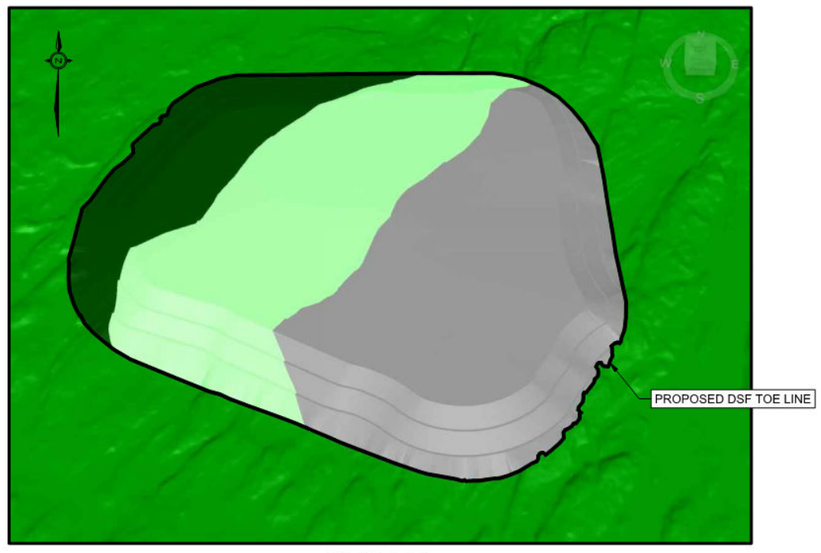
ORIGINAL GROUND (PRIOR TO CONSTRUCTION)
N.T.S.



STAGE 1
(APPROXIMATELY YEAR 6 OF OPERATION)
N.T.S.



STAGE 2
(APPROXIMATELY YEAR 16 OF OPERATION)
N.T.S.



STAGE 3
(APPROXIMATELY YEAR 25 OF OPERATION)
N.T.S.

NOT FOR CONSTRUCTION

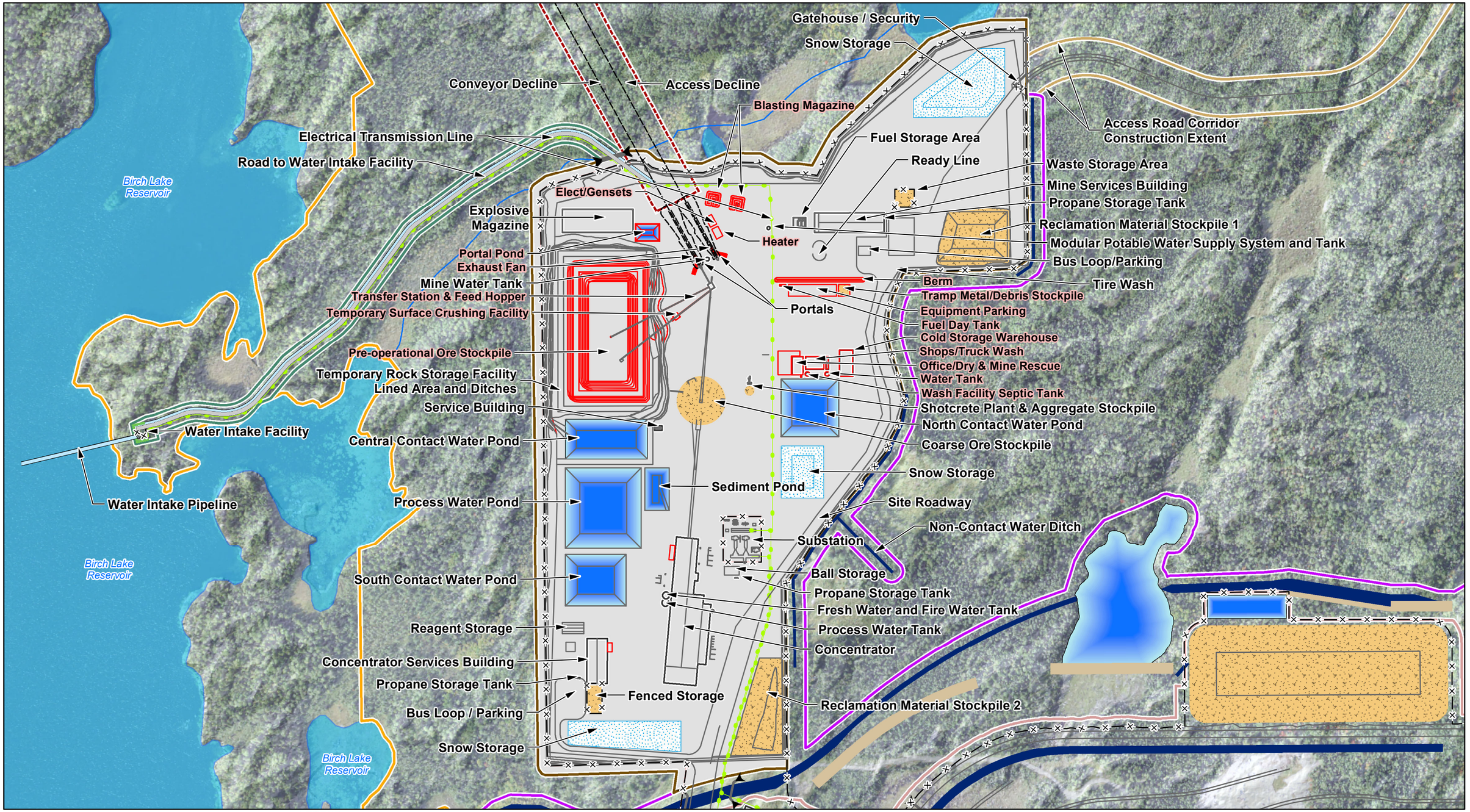
NOTES:
1. DSF - Dry Stack Facility

TWIN METALS MINNESOTA

FIGURE 2-26

DRY STACK FACILITY CONSTRUCTION STAGES

Scale: NOT TO SCALE | Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- Temporary Facilities during Construction
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Water Intake Corridor
- Access Road Corridor

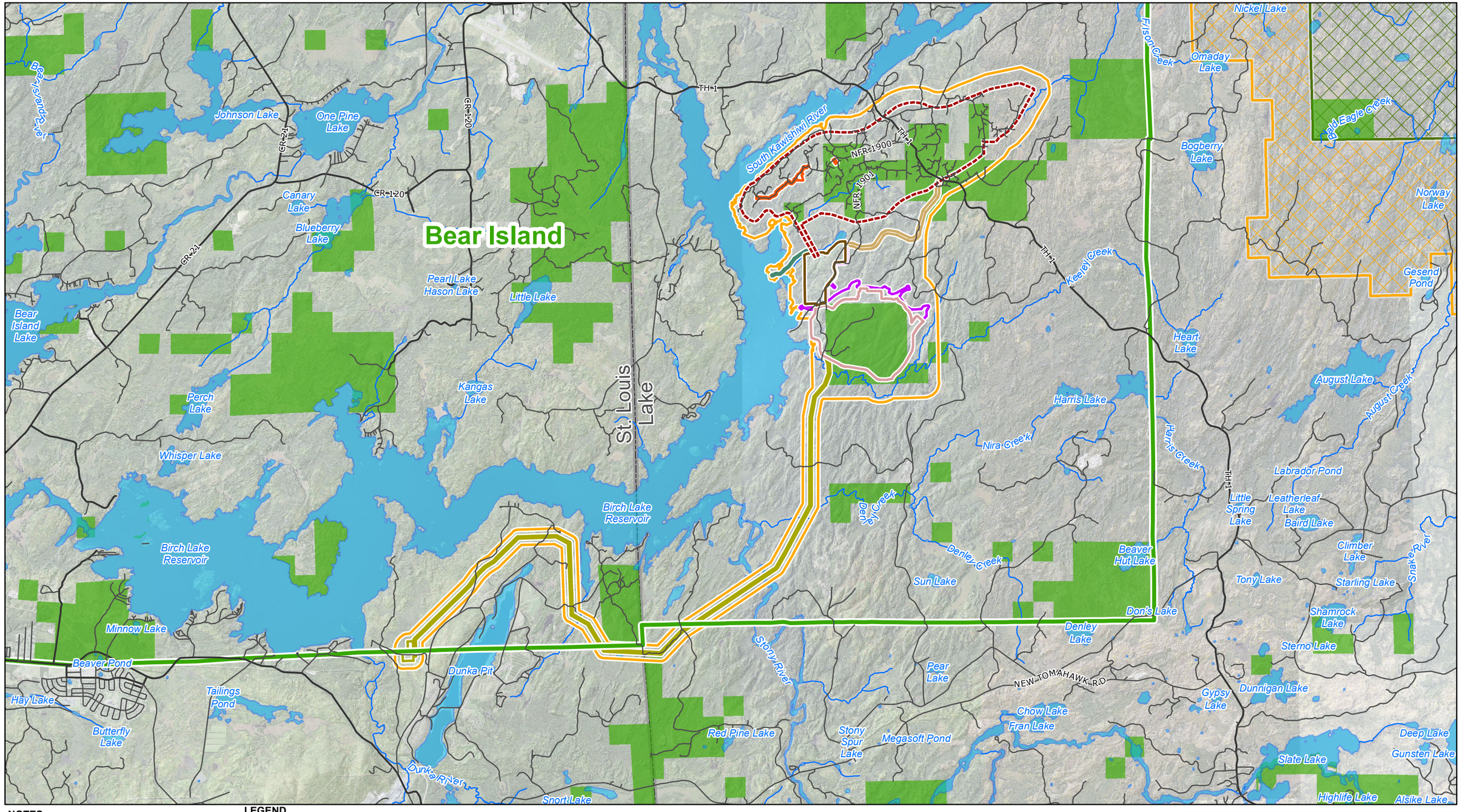
TWIN METALS MINNESOTA

FIGURE 2-27

PLANT SITE CONSTRUCTION PHASE

Scale: 0 250 500 Feet

Date: SEPTEMBER 2019



NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. Boundary Waters Canoe Area Wilderness, Mineral Management Corridor and State Forest data from Minnesota Department of Natural Resources.

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Municipal Boundary
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Boundary Waters Canoe Area Wilderness Mineral Management Corridor
- State Forests - Statutory Boundaries
- State Forests - Management Units
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

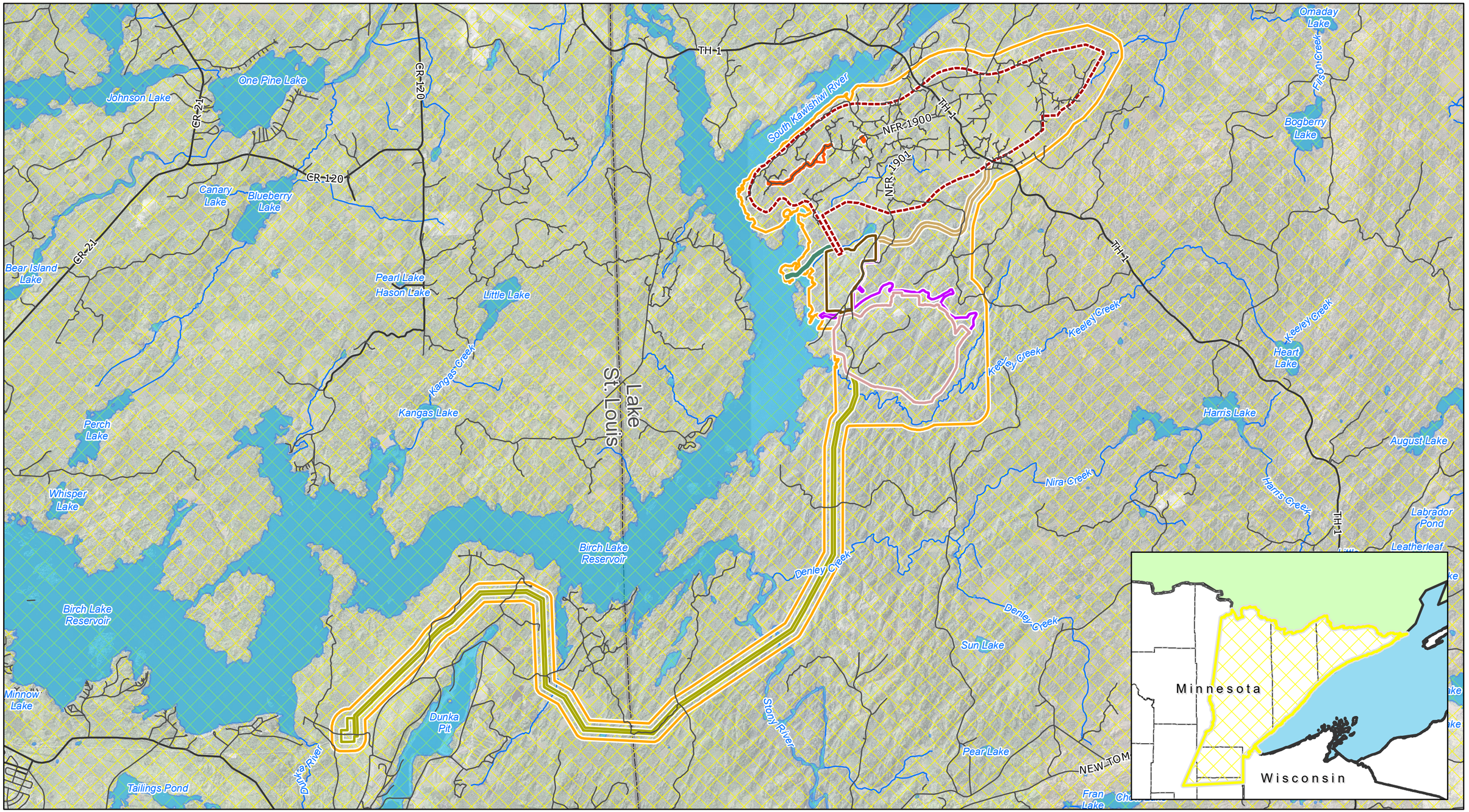
TWIN METALS MINNESOTA

FIGURE 3-1

BWCAW MINERALS MANAGEMENT CORRIDOR AND MDNR STATE FOREST MANAGEMENT UNITS

Scale: 0 3,000 6,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. 1854 Treaty Ceded Territory data from The Great Lakes Indian and Wildlife Commision.

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- 1854 Treaty Ceded Territory
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-2

1854 TREATY CEDED TERRITORY

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

Superior National Forest Plan Management Areas
- General Forest
- Recreation Use in a Scenic Location
- Research Natural Area
- Semi Primitive Motorized Recreation
- Unique Biologic Area

ZONING LEGEND
- Conservancy District -City of Babbitt
- Forest Agricultural Management -St Louis County
- Forest and Recreation -Lake County
- Industrial -St Louis County
- Mineral Mining -City of Babbitt
- MU: Multiple Use -St Louis County
- Residential -St Louis County
- Residential Recreational -Lake County
- Shoreland Multiple Use -St Louis County
- Unknown or Undifferentiated -City of Babbitt
- Shoreland Zoning Provisions

NOTES:
1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND
- Primary Road
- Secondary Road
- Public Waters - Watercourse Delineation
- Public Waters - Basin Delineation
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-3

ZONING AND LAND USE MAP

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

INSET MAP LEGEND

- Private Residence
- Resort
- Residential Recreational -Lake County
- Project Area
- River/Stream
- Lake/Pond

Resort
Private Residence
Private Residence
Private Residence
South Kawishiwi River
Birch Lake Reservoir
0 1,000 2,000 Feet

Fall Lake
TH 1
South Kawishiwi River
NFR 1900
NFR 2101
TH 1
TH 1
Ormaday Lake
Filson Creek
Bogberry Lake
Keeley Creek
Keeley Creek
Keeley Creek
Heart Lake
Harris Lake
August Lake
Harris Creek
Stony River
Mira Creek
TH 1
Labrador Pond
Little Spring Lake
Leatherleaf Lake
Baird Lake
Beaver Hut Lake
Tony Lake
Sun Lake
Denley Creek
Denley Creek
Denley Lake
Pear Lake
NEW TOMAHAWK RD
Fran Lake
Chow Lake
Stony River
Lake St. Louis
Perch Lake
Birch Lake
Whisper Lake
Birch Lake Reservoir
Birch Lake Reservoir
Minnow Lake
Babbitt
Tailings Pond
Dunka River
Dunka Pit

PRIVATE LANDS ZONING LEGEND

- Forest Agricultural Management -St Louis County
- Forest and Recreation -Lake County
- Industrial -St Louis County
- Mineral Mining -City of Babbitt
- Residential -St Louis County
- Residential Recreational -Lake County

NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Property Boundary
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

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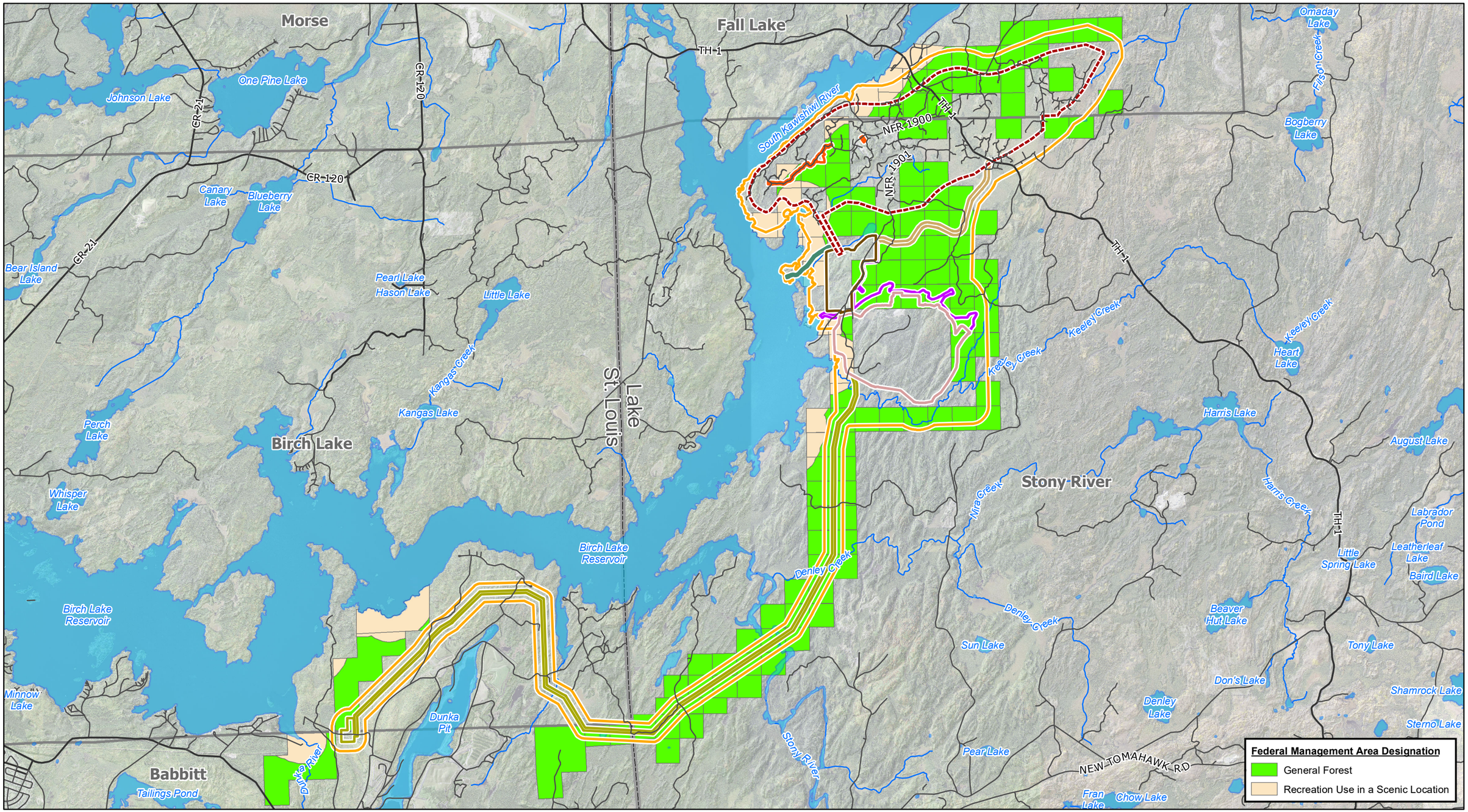
TWIN METALS MINNESOTA

FIGURE 3-4

PRIVATE LANDS ZONING

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-5

FEDERAL LAND USE

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

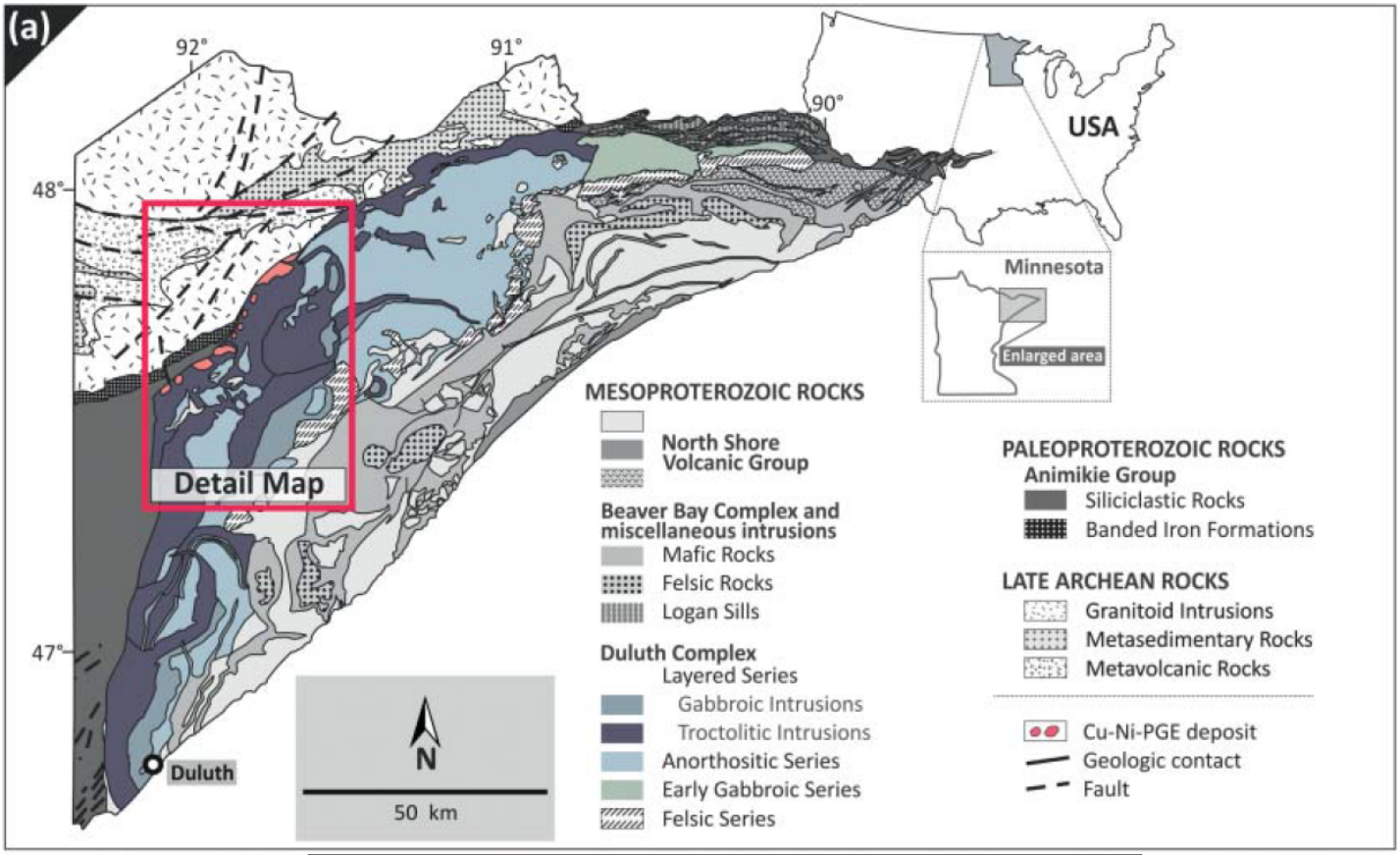
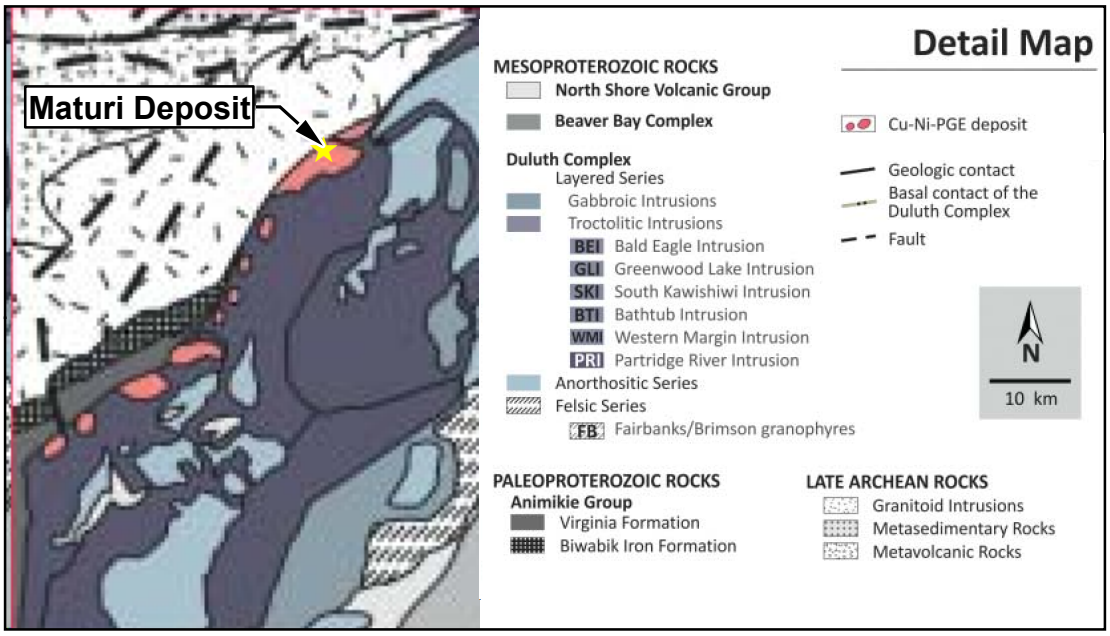


FIG 1. (a) Geologic map of northeastern Minnesota (modified from Miller *et al.* 2001) showing footwall units (Paleoproterozoic and Neoarchean rocks) and the Duluth Complex with its Felsic, Early Gabbroic, Anorthositic, and Layered Series and hanging wall units, which comprise basaltic rocks from the North Shore Volcanic Group.



NOTES:

1. Figure content from Raic, et al. (2015). Arsenic-Rich Cu-Ni-PGE Mineralization in Wetlegs, Duluth Complex, St. Louis County, Minnesota, USA. The Canadian Mineralogist, Vol. 53, pp. 105-132 (2015) DOI: 10.3749/canmin. 1400053

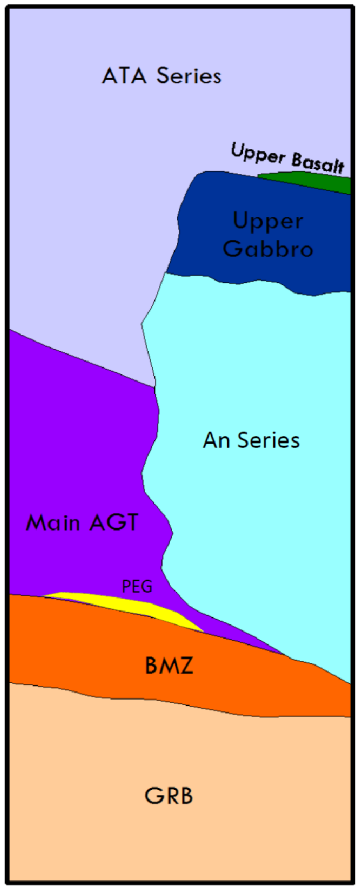
TWIN METALS MINNESOTA

FIGURE 3-6

GEOLOGY OF THE DULUTH COMPLEX

Scale: AS SHOWN	Date: SEPTEMBER 2019

Generalized Stratigraphy of the Maturi Deposit



Keewanawan Rift-Related Package (~1.09 Ga.)

South Kawishiwi Intrusion

ATA Series: Thick upper aspect of the SKI dominated by medium-grained intergranular anorthositic troctolite and troctolitic anorthosite. Commonly weakly to moderately foliated.

Main AGT: Thick homogenous package of medium-grained ophitic augite troctolite. Interpreted to be the liquid phase of the SKI.

PEG: Pegmatoidal to coarse-grained anorthositic troctolite to anorthositic gabbro. Largely barren.

BMZ (Basal Mineralized Zone): Heterogeneous package of mineralized dominantly troctolitic rocks consisting of the UH, S3, S2, and S1 subunits.

Anorthositic Series

Upper Gabbro: Upper mafic phase of the Anorthositic Series. Typified by coarse-grained oxide olivine gabbro to anorthositic gabbro.

An Series: Lower feldspathic aspect of the Anorthositic Series typified by foliated very coarse-grained anorthosite to medium-grained ophitic gabbroic anorthosite or anorthositic gabbro.

North Shore Volcanics

Upper Basalt: Tholeitic basalt inclusion of the extrusive phase of the Mid-Continent Rift.

GRB (Giants Range Batholith): Heterogeneous Archean (~2.68 Ga) granitoid batholith. Dominant lithologies of porphyritic quartz monzonite to diorite. Locally exhibits sulfide mineralization near the contact with and within the contact metamorphic aureole of the SKI.

TWIN METALS MINNESOTA

FIGURE 3-7

MATURI DEPOSIT STRATIGRAPHY

Scale: NOT TO SCALE	Date: SEPTEMBER 2019

GEOLOGY SOURCES:

Boerboom, T.J.; Miller, James D., Jr.. (1994). M-081 Bedrock geologic map of the Silver Island Lake, Wilson Lake, and western Toohey Lake quadrangles, Lake and Cook Counties, Minnesota. Minnesota Geological Survey.

Green, J.C.; Phinney, W.C.; Weiblen, P.W.. (1966). M-002 Gabbro Lake Quadrangle, Lake County, Minnesota. Minnesota Geological Survey.

Green, J.C.; Shulz, Klaus J.. (1982). M-050 Geologic map of the Ely Quadrangle, Lake and St. Louis Counties, Minnesota. Minnesota Geological Survey.

Jirsa, M.A.; Boerboom, T.J.; Chandler, V.W.. (2012). S-22, Geologic Map of Minnesota, Precambrian Bedrock Geology.

Miller, James D., Jr.; Green, J.C.; Severson, M.J.; Chandler, V.W.; Peterson, D.M.. (2001). M-119 Geologic map of the Duluth Complex and related rocks, northeastern Minnesota. Minnesota Geological Survey.

Miller, James D., Jr.; Severson, M.J.. (2005). M-159 Bedrock geology of the Babbitt quadrangle, St. Louis and Lake Counties, Minnesota. Minnesota Geological Survey.

Miller, James D., Jr.; Severson, M.J.. (2005). M-160 Bedrock geology of the Babbitt Northeast quadrangle, St. Louis and Lake Counties, Minnesota. Minnesota Geological Survey.

Severson, M.J.; Miller, James D., Jr.. (1999). M-091 Bedrock geologic map of Allen quadrangle, St. Louis County, Minnesota. Minnesota Geological Survey.

Twin Metals Minnesota

BEDROCK GEOLOGY

Mesoproterozoic -Duluth Complex

- Mbe — Bald Eagle Intrusion
- Mat — ATA Series
- Magt — Main AGT
- Mbmz — Basal Mineralized Zone
- Mnl — Nickel Lake Macrodike
- Mhb — Basalt Hornfels
- Mdb — Diabase
- Mas — Anorthositic Series

Paleoproterozoic -Animike Group

- Mas — Virginia Formation
- Pbif — Biwabik Iron Formation

Neoarchean

- Agc — Giants Range Batholith -Clear Lake Phase
- Age — Giants Range Batholith -Embarrass Phase
- Agf — Giants Range Batholith -Farm Lake Phase
- Agt — Giants Range Batholith -Tonalitic Phase

NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-8

REGIONAL BEDROCK GEOLOGY

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

2952429 E
806973 N

A

2956913 E
798850 N

A'

Birch Lake Reservoir

Ground Surface

Underground Mine Area Does
Not Extend Under Birch Lake Reservoir

Mbmz

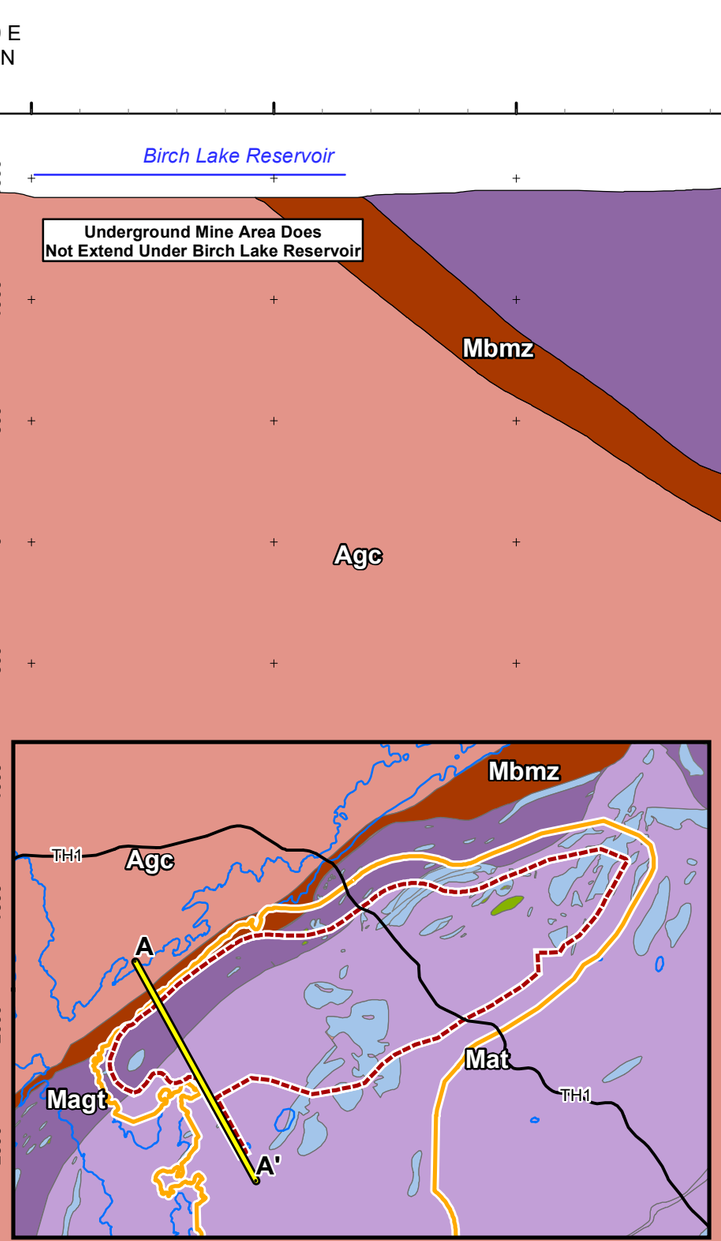
Agc

Mat

Magt

Elevation AMSL (ft)

1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000



NOTES:

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

LEGEND

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

Geologic Unit

- Magt — Main Augite troctolite
- Mat — Anorthositic troctolite to troctolitic anorthorsite
- Mbmz — Basal Mineralized Zone
- Agc — Giants Range Batholith

TWIN METALS MINNESOTA

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TWIN METALS MINNESOTA

FIGURE 3-9

BEDROCK CROSS SECTION A-A'
UNDERGROUND MINE AREA

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019

2955309 E
810068 N

B

2961518 E
801164 N

B'

Birch Lake Reservoir

Ground Surface

Underground Mine Area Does Not Extend Under Birch Lake Reservoir

Mbmz

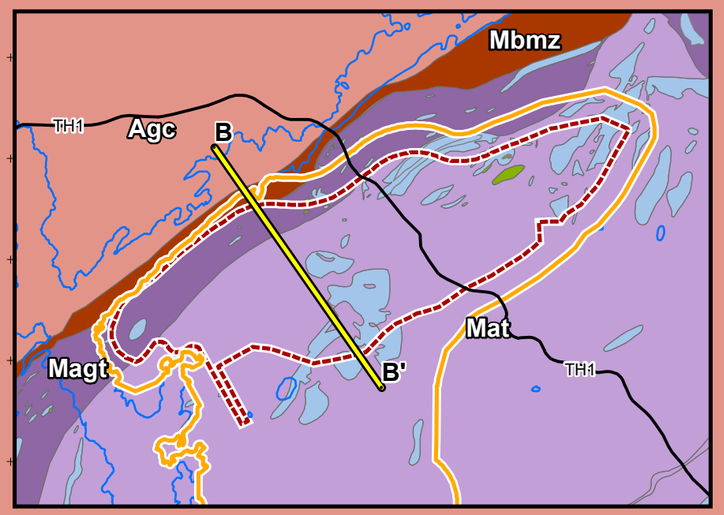
Agc

Mat

Magt

Elevation AMSL (ft)

1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500



NOTES:

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

LEGEND

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

Geologic Unit

- Magt — Main Augite troctolite
- Mat — Anorthositic troctolite to troctolitic anorthosite
- Mbmz — Basal Mineralized Zone
- Agc — Giants Range Batholith

TWIN METALS MINNESOTA

N

TWIN METALS MINNESOTA

FIGURE 3-10

BEDROCK CROSS SECTION B-B'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019

2959703 E
813457 N

C

2967755 E
804159 N

C'

Birch Lake Reservoir

Ground Surface

Underground Mine Area Does Not Extend Under Birch Lake Reservoir

Mat

Mat

UB

Magt

UG

Mas

Mat

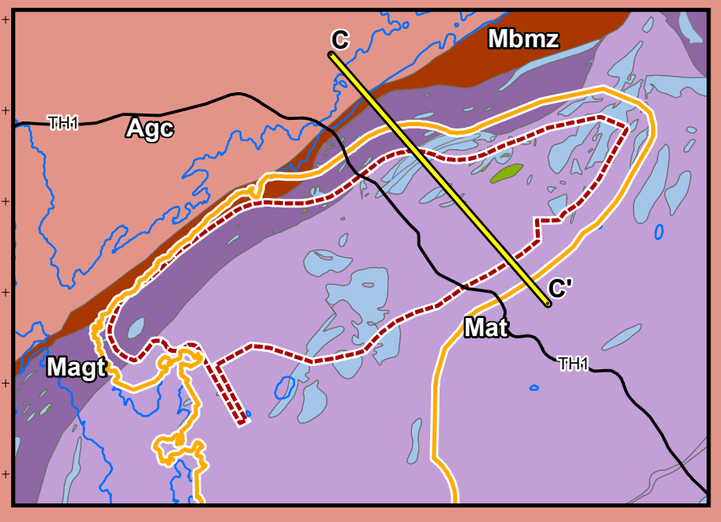
Magt

Mbmz

Agc

Elevation AMSL (ft)

1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
-4000



NOTES:

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

LEGEND

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

Geologic Unit

Magt	Main Augite troctolite
Mat	Anorthositic troctolite to troctolitic anorthosite
Mbmz	Basal Mineralized Zone
UG	Upper Gabbro
Mas	Anorthositic Series
UB	Upper Basalt
Agc	Giants Range Batholith

TWIN METALS MINNESOTA

N

TWIN METALS MINNESOTA

FIGURE 3-11

BEDROCK CROSS SECTION C-C'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 250 500 Feet

Date: SEPTEMBER 2019

2951223 E
802812 N

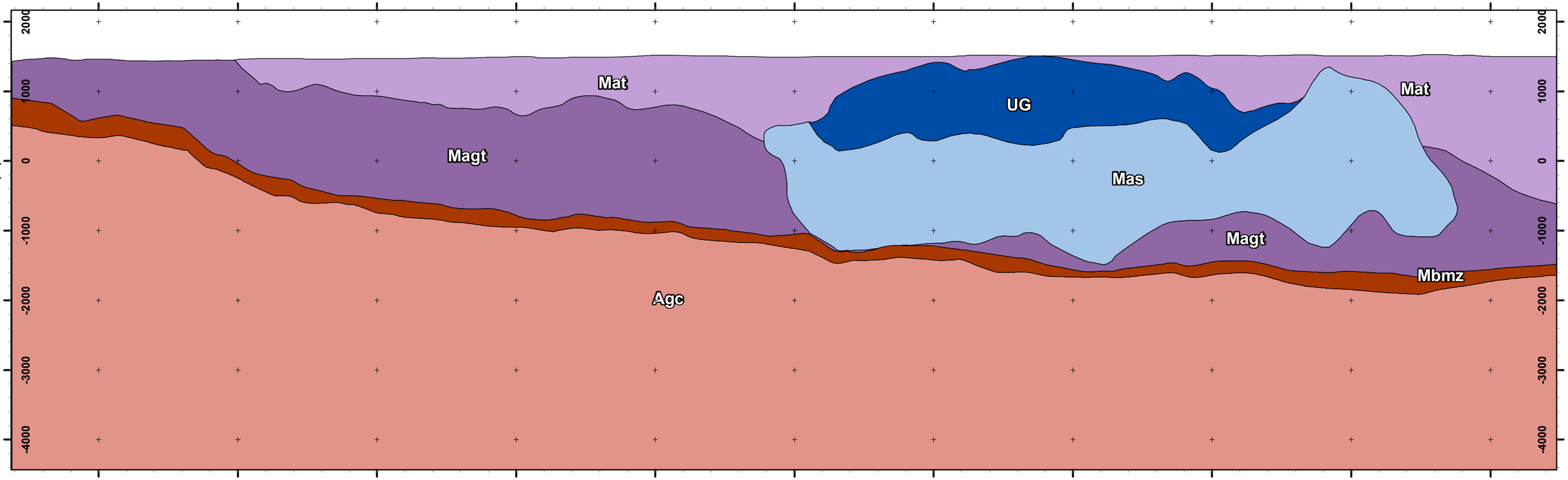
D

2971693 E
811443 N

D'

Elevation AMSL (ft)

2000
1000
0
-1000
-2000
-3000
-4000



NOTES:

1. Quaternary sediments and lake bathymetry not shown as thicknesses and depths are generally less than 20 feet and not seen at this scale.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Horizontal and vertical scale are as shown. Vertical exaggeration is 1.

LEGEND

- Cross Section Line
- Primary Road
- Project Area
- Underground Mine Area
- Lake/Pond

Geologic Unit

- Magt — Main Augite troctolite
- Mat — Anorthositic troctolite to troctolitic anorthosite
- Mbmz — Basal Mineralized Zone
- UG — Upper Gabbro
- Mas — Anorthositic Series
- Agc — Giants Range Batholith

TWIN METALS MINNESOTA

N

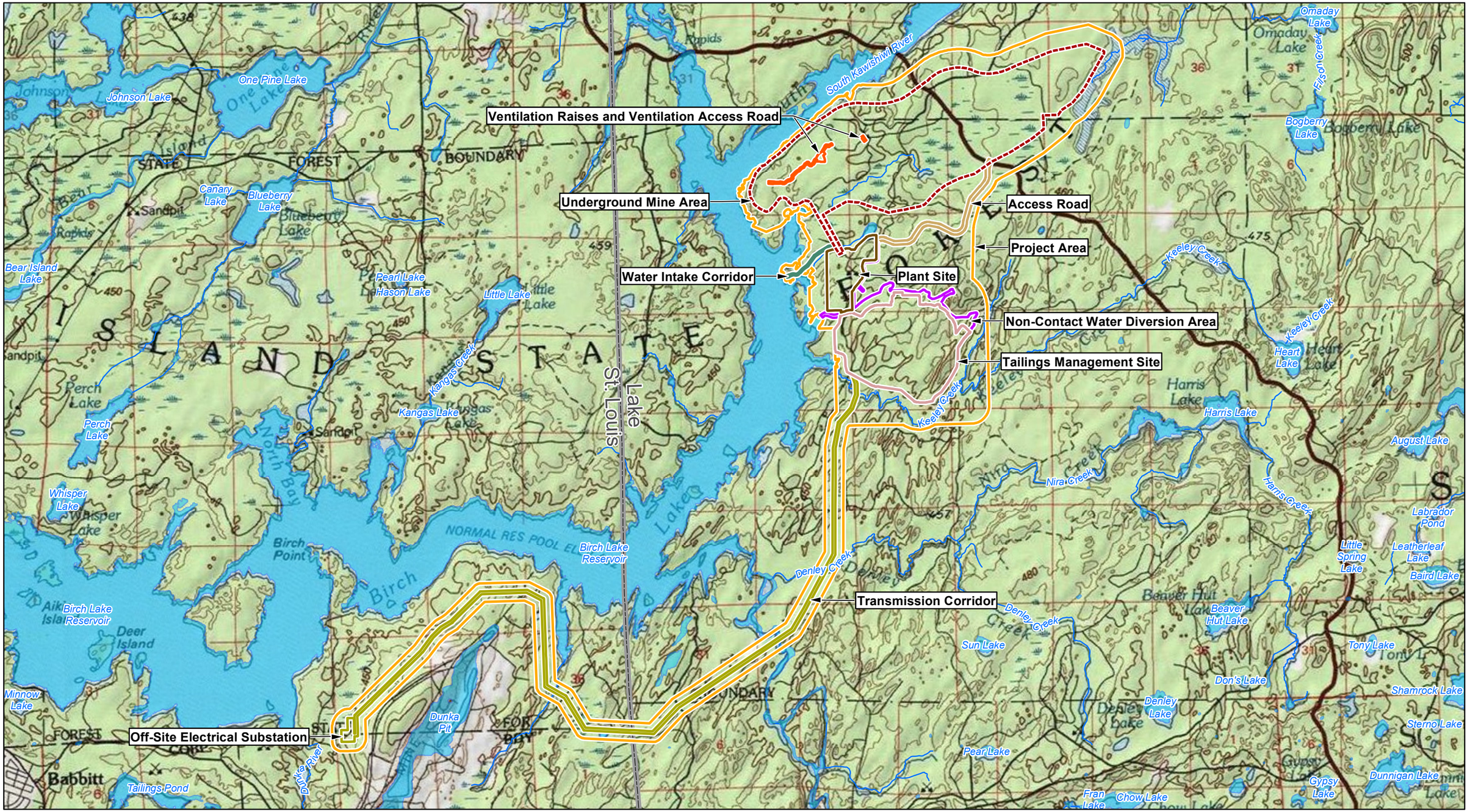
TWIN METALS MINNESOTA

FIGURE 3-12

BEDROCK CROSS SECTION D-D'
UNDERGROUND MINE

Horizontal & Vertical Scale: 0 750 1,500 Feet

Date: SEPTEMBER 2019



NOTES:

1. USDA Topographic basemap supplied by esri.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road

TWIN METALS MINNESOTA

FIGURE 3-13

PROJECT AREA TOPOGRAPHY

Scale: 0 2,500 5,000 Feet

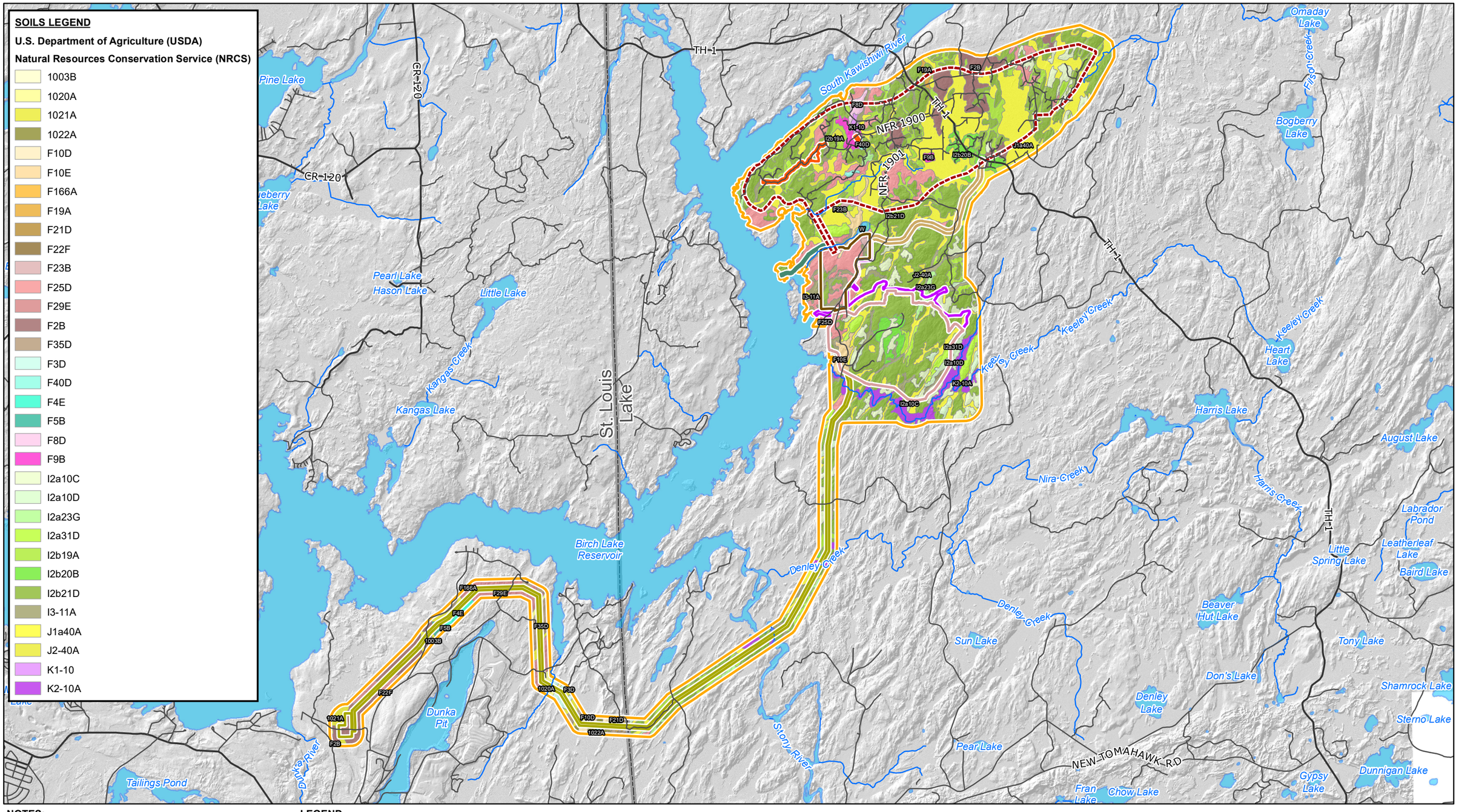
Date: September 2019

SOILS LEGEND

U.S. Department of Agriculture (USDA)

Natural Resources Conservation Service (NRCS)

- 1003B
- 1020A
- 1021A
- 1022A
- F10D
- F10E
- F166A
- F19A
- F21D
- F22F
- F23B
- F25D
- F29E
- F2B
- F35D
- F3D
- F40D
- F4E
- F5B
- F8D
- F9B
- I2a10C
- I2a10D
- I2a23G
- I2a31D
- I2b19A
- I2b20B
- I2b21D
- I3-11A
- J1a40A
- J2-40A
- K1-10
- K2-10A



NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. Soils data downloaded from the U.S. Department of Agriculture (https://websoilsurvey.sc.egov.usda.gov).
4. See Table 5-1 for soil descriptions.

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-14

U.S. DEPARTMENT OF AGRICULTURE
NRCS SOILS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

SOILS LEGEND

U.S. Forest Service (USFS)

Ecological (ELT) Land Type

- 1
- 4
- 5
- 7
- 10
- 14
- 18
- 21
- 24
- 28
- 30
- 32
- 46
- 47
- 89
- 99

NOTES:

1. Hydrographic data from Minnesota Department of Natural Resources.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. Terrestrial Ecological Unit Inventory (soils) data from the United States Forest Service.
4. See Table 5-2 for soil descriptions.

LEGEND

- River/Stream
- Primary Road
- Secondary Road
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

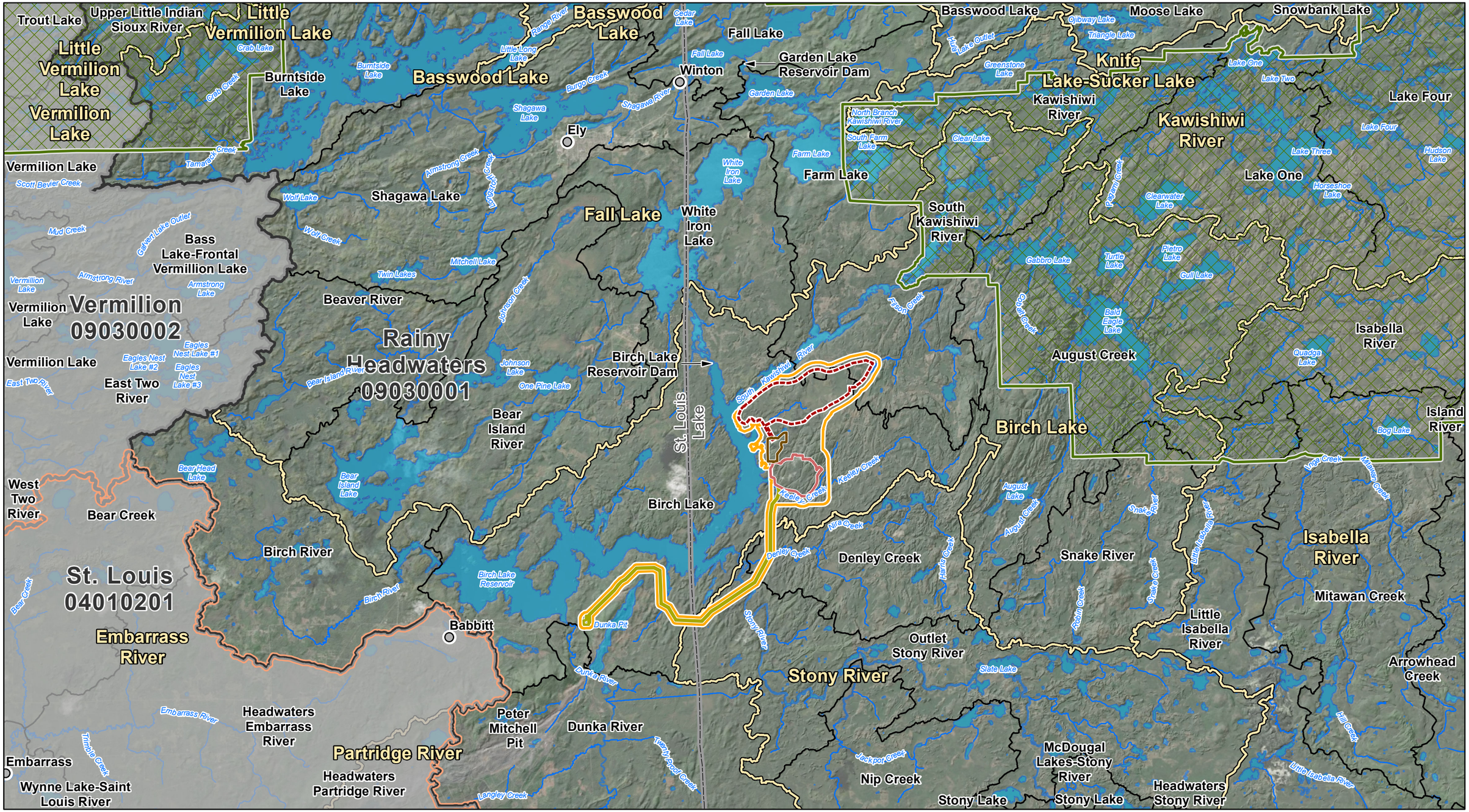
TWIN METALS MINNESOTA

FIGURE 3-15

U.S. FOREST SERVICE ELT SOILS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from Esri World Imagery map service.
2. Watershed data from the U.S. Geological Survery Watershed Boundary Dataset (WBD).
3. Hydrographic data from Minnesota Department of Natural Resources.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Place Name
- River/Stream
- Lake/Pond
- Watershed Boundary Hydrological Unit Code 8
- Watershed Boundary Hydrological Unit Code 10
- Watershed Boundary Hydrological Unit Code 12
- Laurentian Divide
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

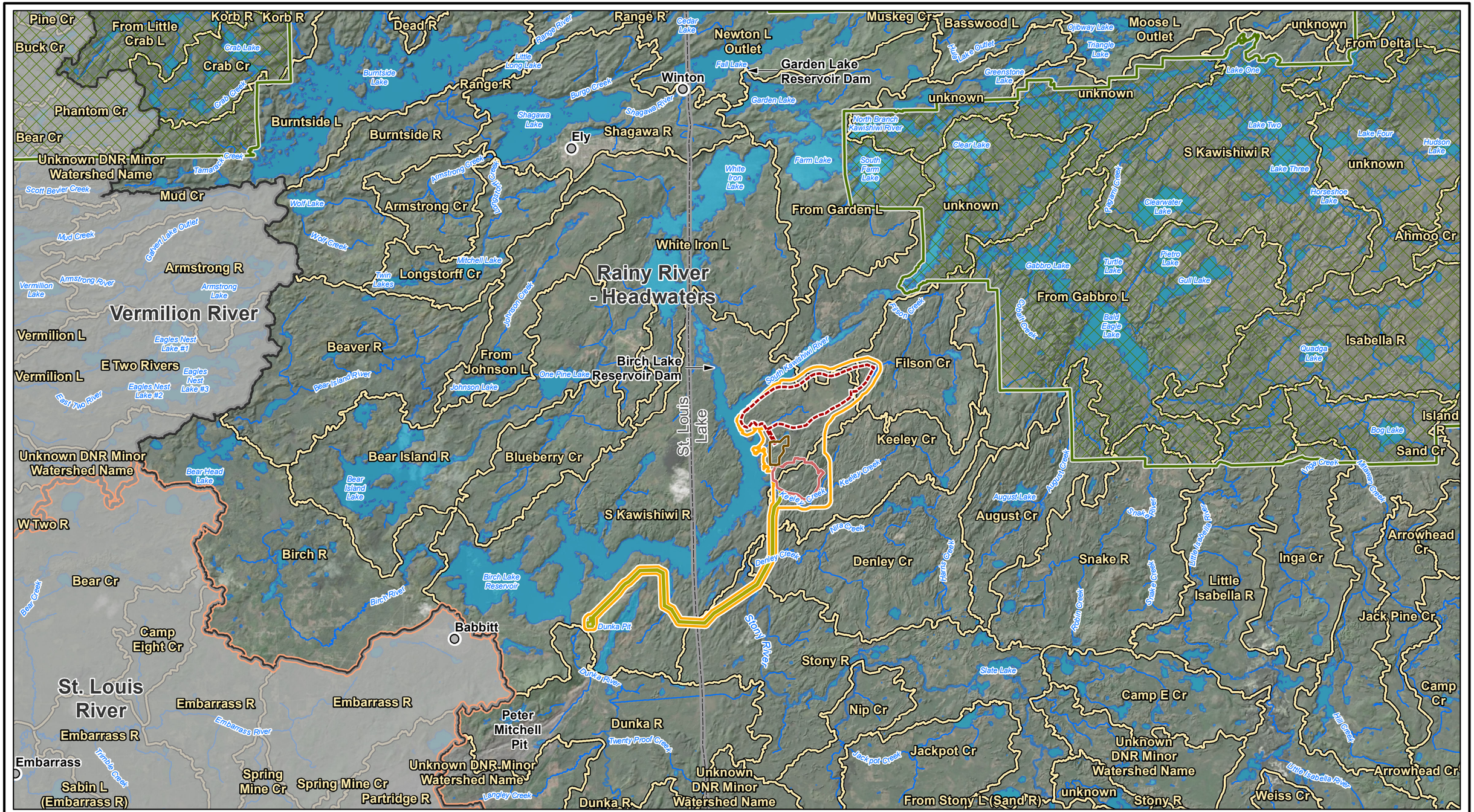
TWIN METALS MINNESOTA

FIGURE 3-16

U.S. GEOLOGICAL SURVEY
HYDROLOGICAL UNIT CODE WATERSHEDS

Scale: 0 1.25 2.5 Miles

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from Esri World Imagery map service.
2. Hydrographic and watershed data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Place Name
- Major Watershed Boundary
- Minor Watershed Boundary
- River/Stream
- Lake/Pond
- Laurentian Divide
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

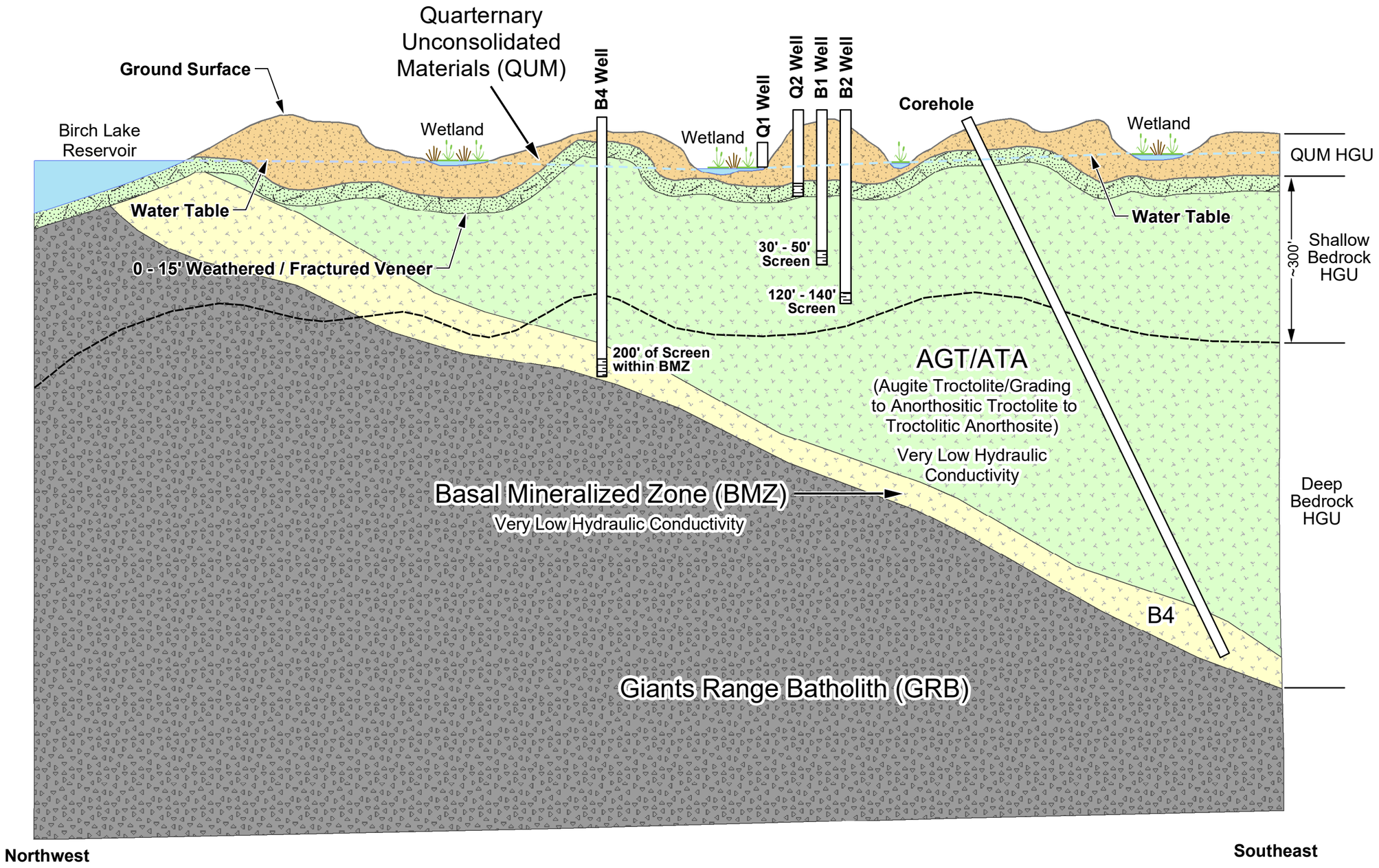
TWIN METALS MINNESOTA

FIGURE 3-17

MINNESOTA DEPARTMENT OF NATURAL RESOURCES WATERSHEDS

Scale: 0 1.25 2.5 Miles

Date: SEPTEMBER 2019



NOTES:

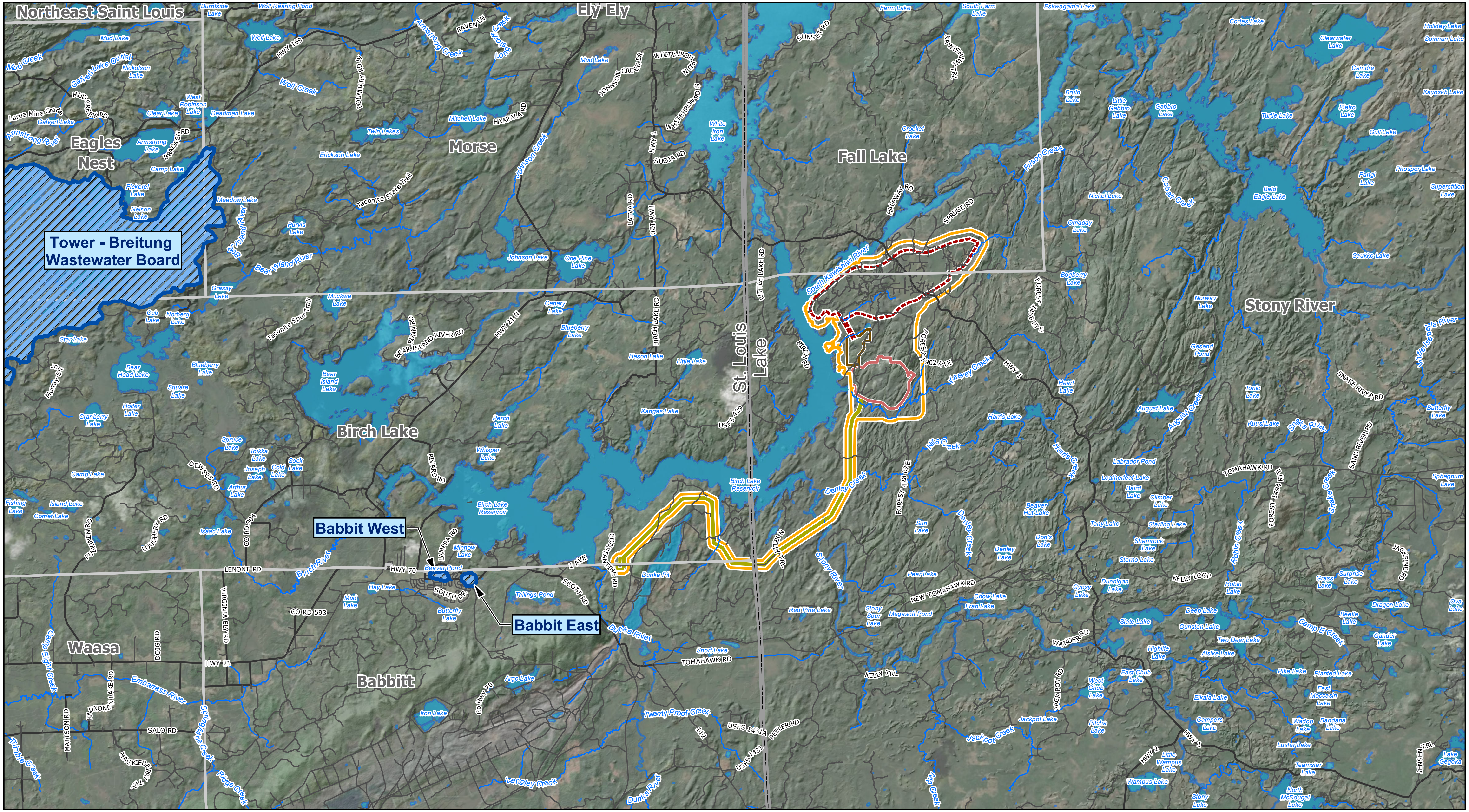
1. Figure is conceptual, not to scale and to be used for purposes of discussion.

TWIN METALS MINNESOTA

FIGURE 3-18

CONCEPTUAL HYDROLOGIC MODEL - HGUS

Scale: NOT TO SCALE	Date: SEPTEMBER 2019



NOTES:
1. Base air photo from Esri World Imagery map service.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Wellhead protection areas from Minnesota Department of Health.

LEGEND
- Wellhead Protection Area
- River/Stream
- Primary Road
- Secondary Road
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Transmission Corridor

TWIN METALS MINNESOTA

N

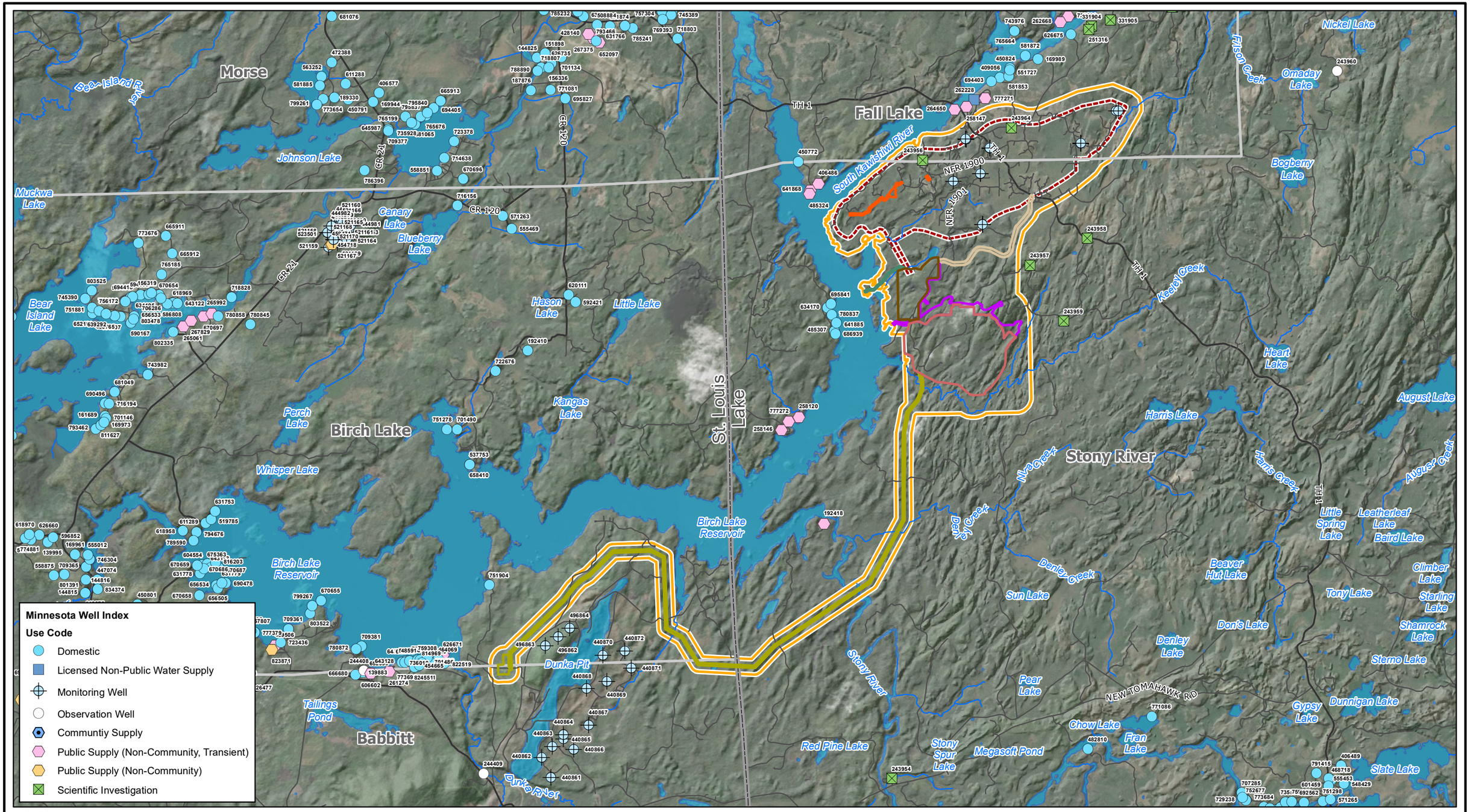
TWIN METALS MINNESOTA

FIGURE 3-19

WELLHEAD PROTECTION AREA

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from Esri World Imagery map service.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Minnesota Well Index data from Minnesota Geological Survey (October 2018).

LEGEND

- River/Stream
- Primary Road
- Secondary Road
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raise and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-20

MINNESOTA WELL INDEX MAP

Scale: 0 3,000 6,000 Feet

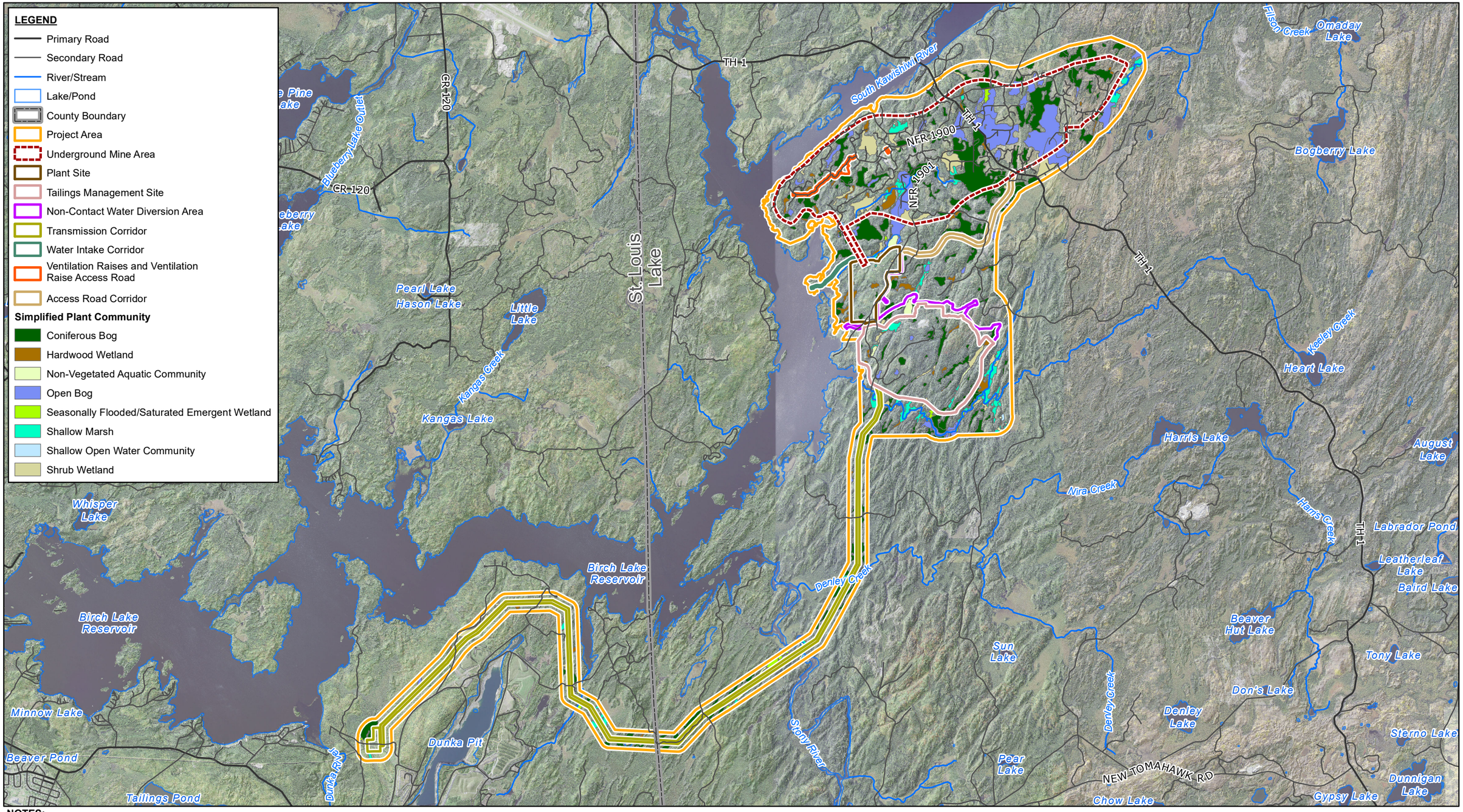
Date: SEPTEMBER 2019

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

Simplified Plant Community

- Coniferous Bog
- Hardwood Wetland
- Non-Vegetated Aquatic Community
- Open Bog
- Seasonally Flooded/Saturated Emergent Wetland
- Shallow Marsh
- Shallow Open Water Community
- Shrub Wetland



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and National Wetlands Inventory (NWI) data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

TWIN METALS MINNESOTA

FIGURE 3-21

NATIONAL WETLANDS INVENTORY
SIMPLIFIED PLANT COMMUNITY CLASSIFICATION

Scale: 0 2,500 5,000 Feet

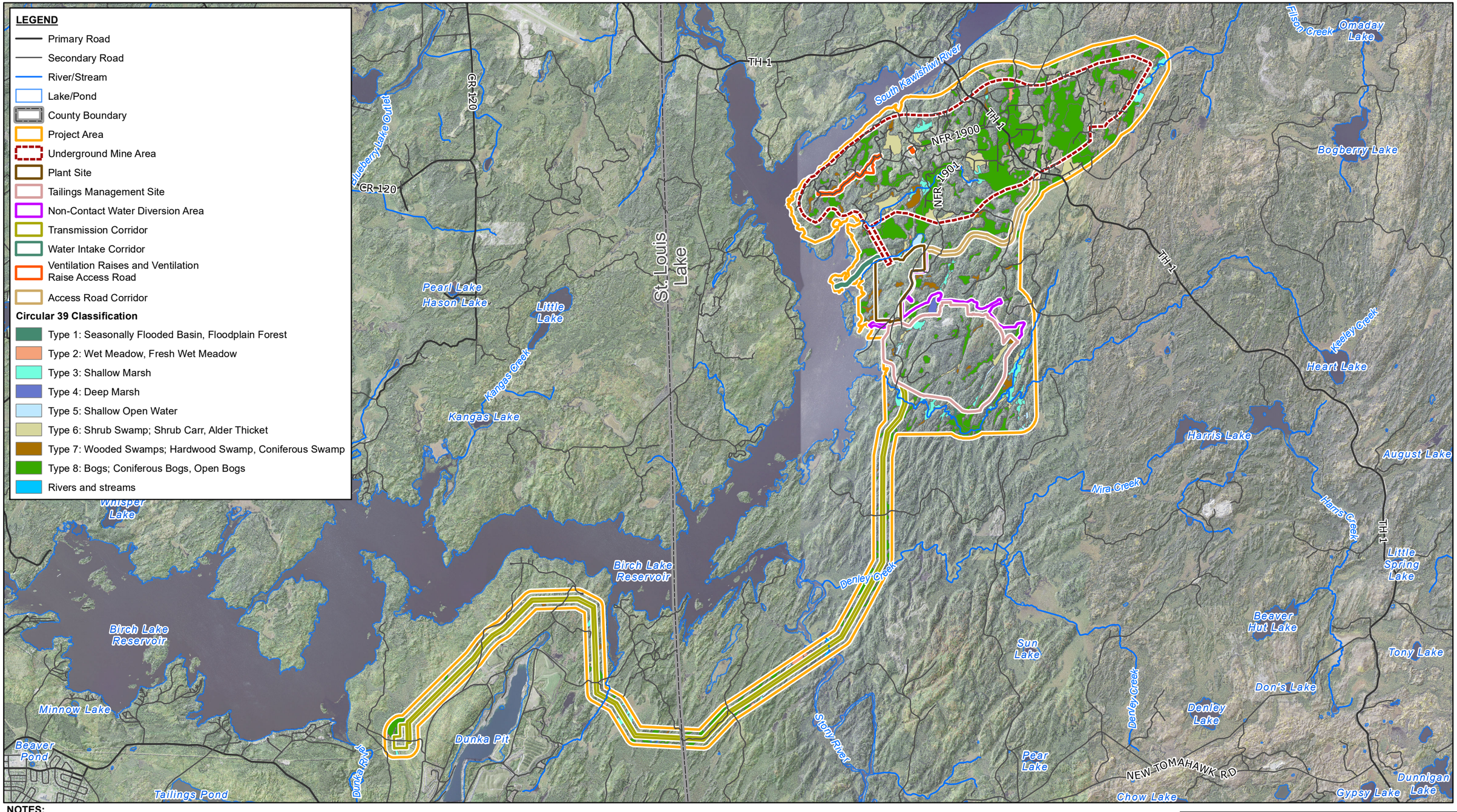
Date: SEPTEMBER 2019

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

Circular 39 Classification

- Type 1: Seasonally Flooded Basin, Floodplain Forest
- Type 2: Wet Meadow, Fresh Wet Meadow
- Type 3: Shallow Marsh
- Type 4: Deep Marsh
- Type 5: Shallow Open Water
- Type 6: Shrub Swamp; Shrub Carr, Alder Thicket
- Type 7: Wooded Swamps; Hardwood Swamp, Coniferous Swamp
- Type 8: Bogs; Coniferous Bogs, Open Bogs
- Rivers and streams



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and National Wetlands Inventory (NWI) data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

TWIN METALS MINNESOTA

N

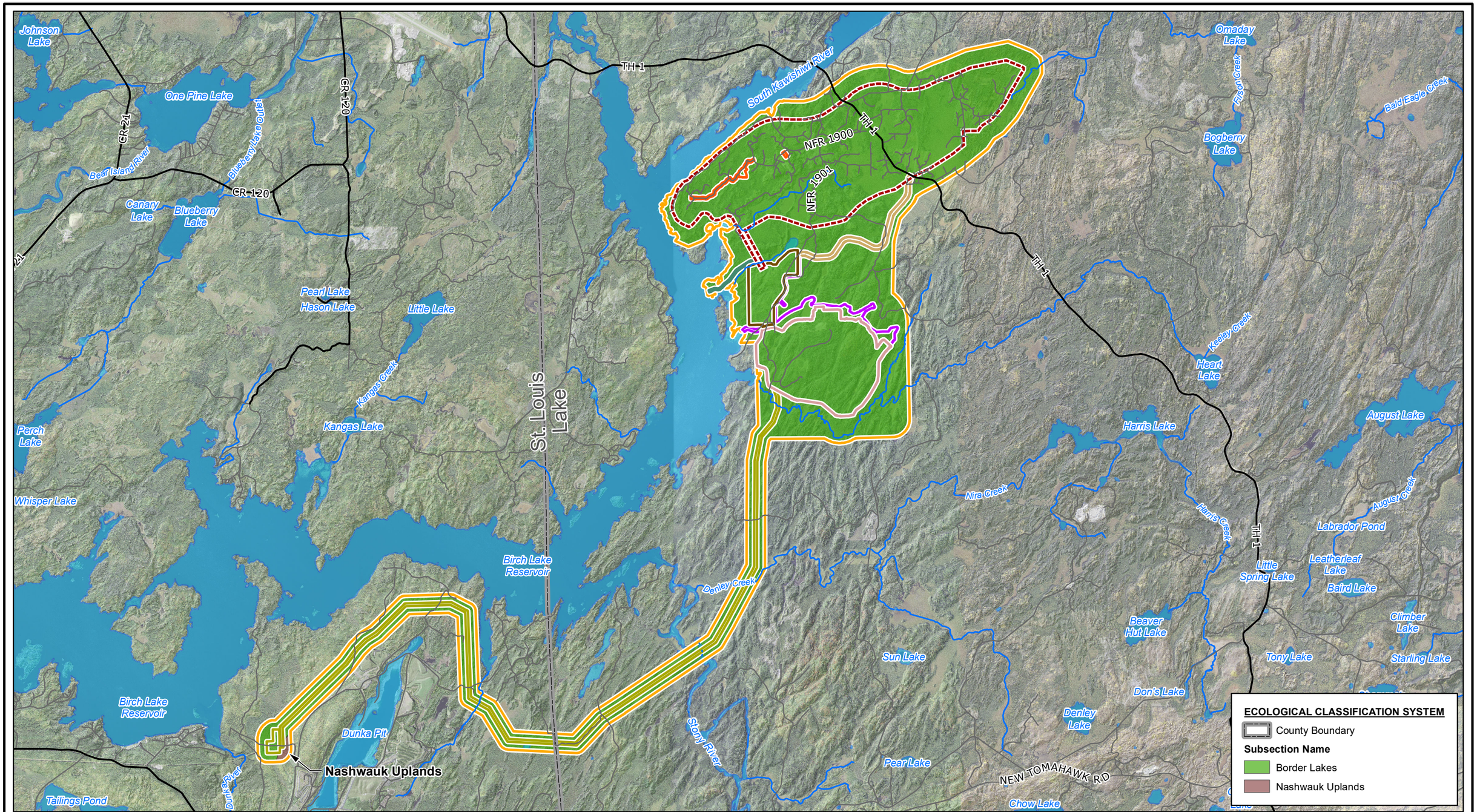
TWIN METALS MINNESOTA

FIGURE 3-22

NATIONAL WELTANDS INVENTORY
CIRCULAR 39 CLASSIFICATION

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and Ecological Classification System (ECS) data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

N

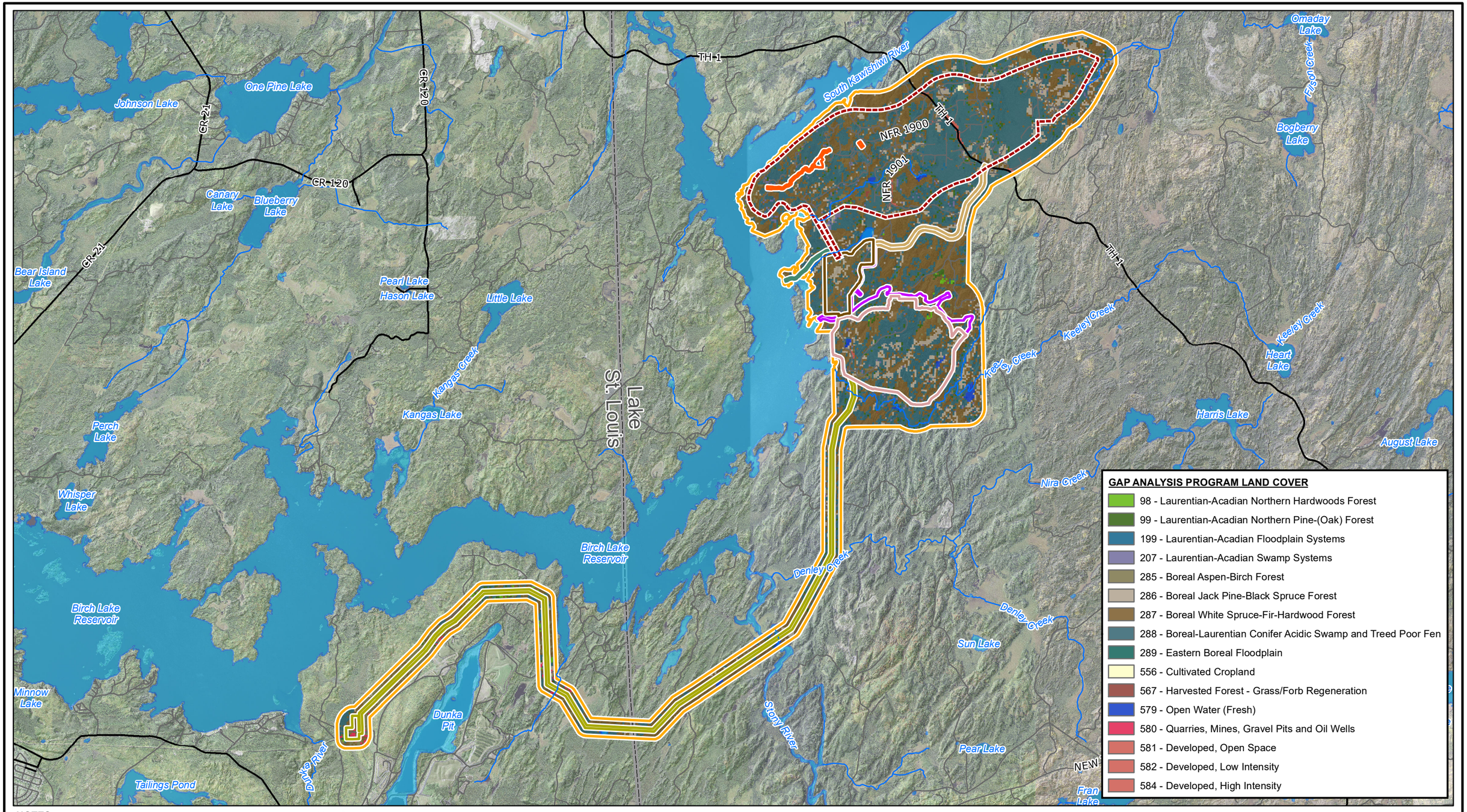
TWIN METALS MINNESOTA

FIGURE 3-23

ECOLOGICAL CLASSIFICATION SYSTEM SUBSECTIONS

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



GAP ANALYSIS PROGRAM LAND COVER

- 98 - Laurentian-Acadian Northern Hardwoods Forest
- 99 - Laurentian-Acadian Northern Pine-(Oak) Forest
- 199 - Laurentian-Acadian Floodplain Systems
- 207 - Laurentian-Acadian Swamp Systems
- 285 - Boreal Aspen-Birch Forest
- 286 - Boreal Jack Pine-Black Spruce Forest
- 287 - Boreal White Spruce-Fir-Hardwood Forest
- 288 - Boreal-Laurentian Conifer Acidic Swamp and Treed Poor Fen
- 289 - Eastern Boreal Floodplain
- 556 - Cultivated Cropland
- 567 - Harvested Forest - Grass/Forb Regeneration
- 579 - Open Water (Fresh)
- 580 - Quarries, Mines, Gravel Pits and Oil Wells
- 581 - Developed, Open Space
- 582 - Developed, Low Intensity
- 584 - Developed, High Intensity

NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. GAP Land Cover data downloaded from the U.S. Geological Survey. https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/land-cover

LEGEND

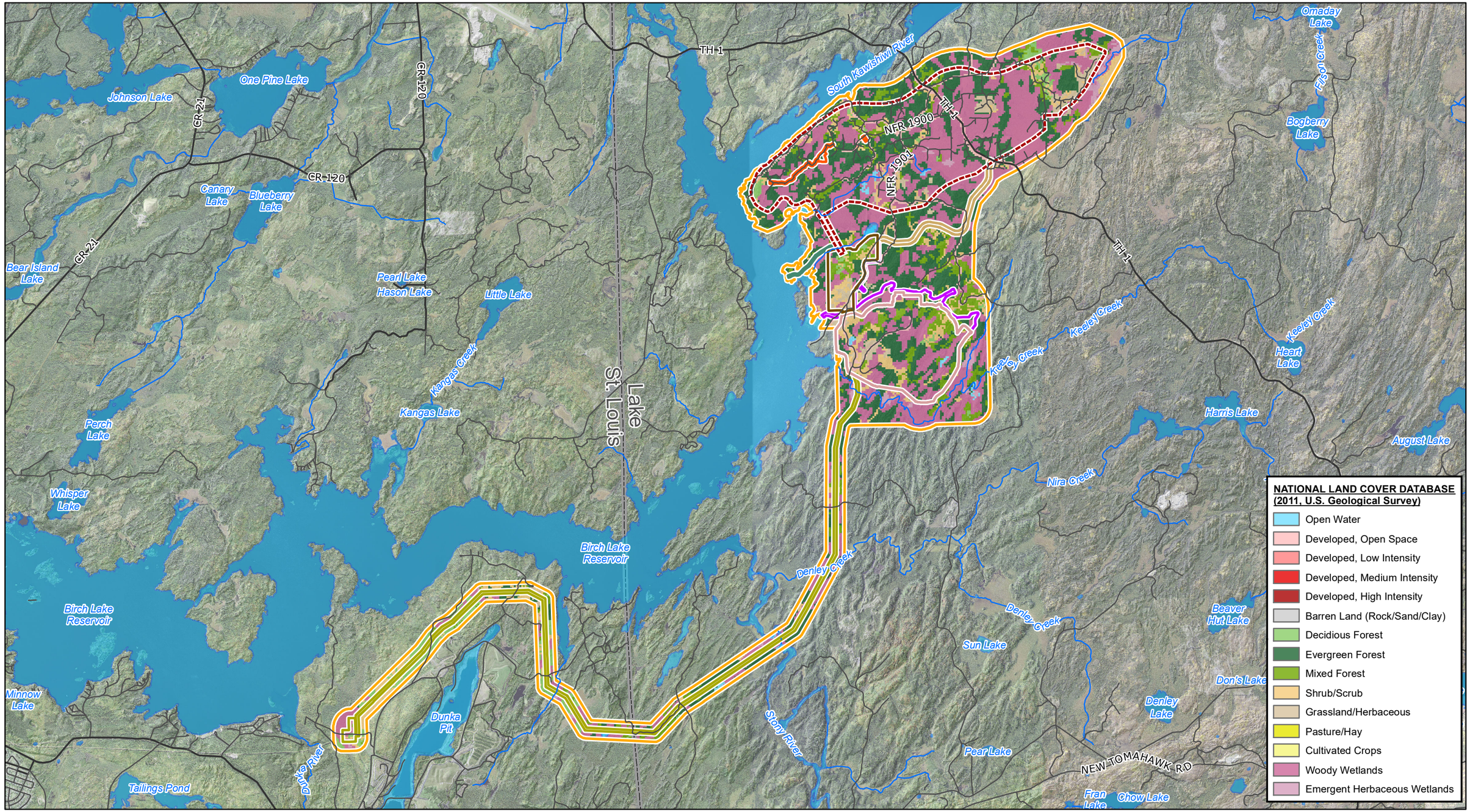
- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- County Boundary
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-24
U.S. GEOLOGICAL SURVEY NATIONAL GAP ANALYSIS PROGRAM
PROJECT LAND COVER

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NATIONAL LAND COVER DATABASE (2011, U.S. Geological Survey)

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Decidious Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. National Land Cover Database classification data downloaded from the U.S. Geological Survey. https://catalog.data.gov/dataset/usgs-national-land-cover-dataset-nlcd-downloadable-data-collection

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

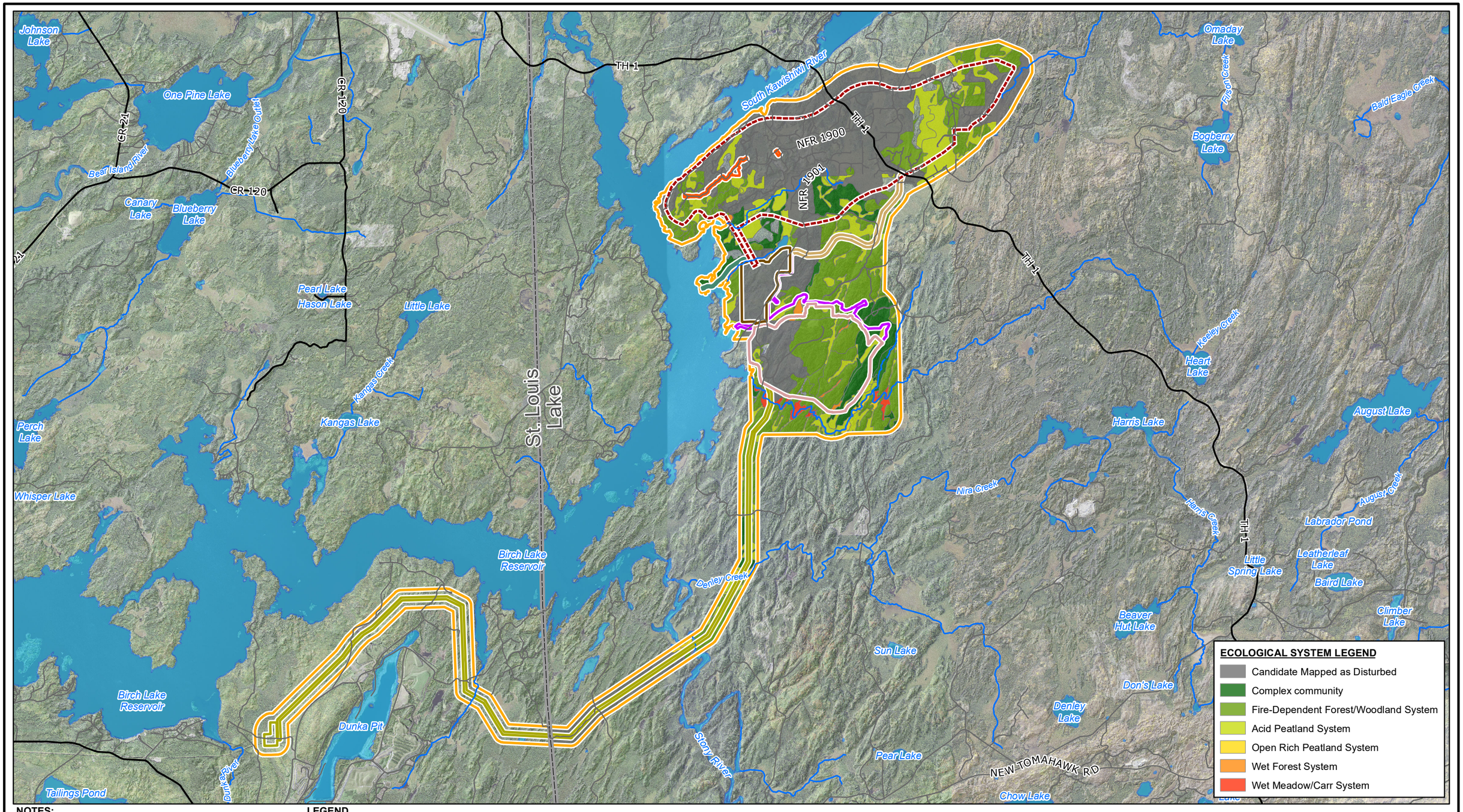
TWIN METALS MINNESOTA

FIGURE 3-25

U.S. GEOLOGICAL SURVEY
NATIONAL LAND COVER DATABASE
LAND COVER

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic and Minnesota Biological Survey (MBS) data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-26

MINNESOTA BIOLOGICAL SURVEY DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

Copyright 2017, State of Minnesota, Department of Natural Resources (DNR). Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota DNR, and were current as of October 2018. These data are not based on an exhaustive inventory of the state. The lack of data for any geographic area shall not be construed to mean that no significant features are present.

CRITICAL HABITAT AND NHIS LEGEND

- Gray Wolf Critical Habitat
- Canada Lynx Critical Habitat

Protection Status

- Special Concern
- Threatened

Montane Yellow-Eyed Grass

Eastern Heather Vole

Little Brown Myotis

Franklin's Phacelia

St. Lawrence Grapefern

Blunt-Lobed Grapefern

Mingan Moonwort

Small Green Wood Orchid

Eastern Candlewax Lichen

One Pine Lake
CR-120
Canary Lake
Blueberry Lake
CR-21
Bear Island Lake
Pearl Lake
Hason Lake
Little Lake
Kangas Creek
Kangas Lake
Perch Lake
Whisper Lake
Birch Lake Reservoir
Minnow Lake
Dunka Pit
Dunka River
Tailings Pond
St. Louis River
Lake
South Kawishiwi River
NFR 1900
TH-1
Omaday Lake
Elbow Creek
Bogberry Lake
Keeley Creek
Heart Lake
Harris Lake
August Lake
Nira Creek
Harris Creek
Labrador Pond
Leatherleaf Lake
Little Spring Lake
Baird Lake
Denley Creek
Beaver Hut Lake
Sun Lake
Tony Lake
Don's Lake
Shamrock Lake
Denley Lake
Sterno Lake
Stony River
Pear Lake
NEW TOMAHAWK RD
Dunnigan Lake
Gypsy Lake
Fran Lake
Chow Lake

NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
4. Rare Features Data included here were provided by the Division of Ecological and Water Resources, Minnesota Department of Natural Resources. (See Copyright Statement above)
5. Critical Habitat Data downloaded from U.S. Fish and Wildlife Service.https://ecos.fws.gov/ecp/report/table/critical-habitat.html

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

TWIN METALS MINNESOTA

FIGURE 3-27

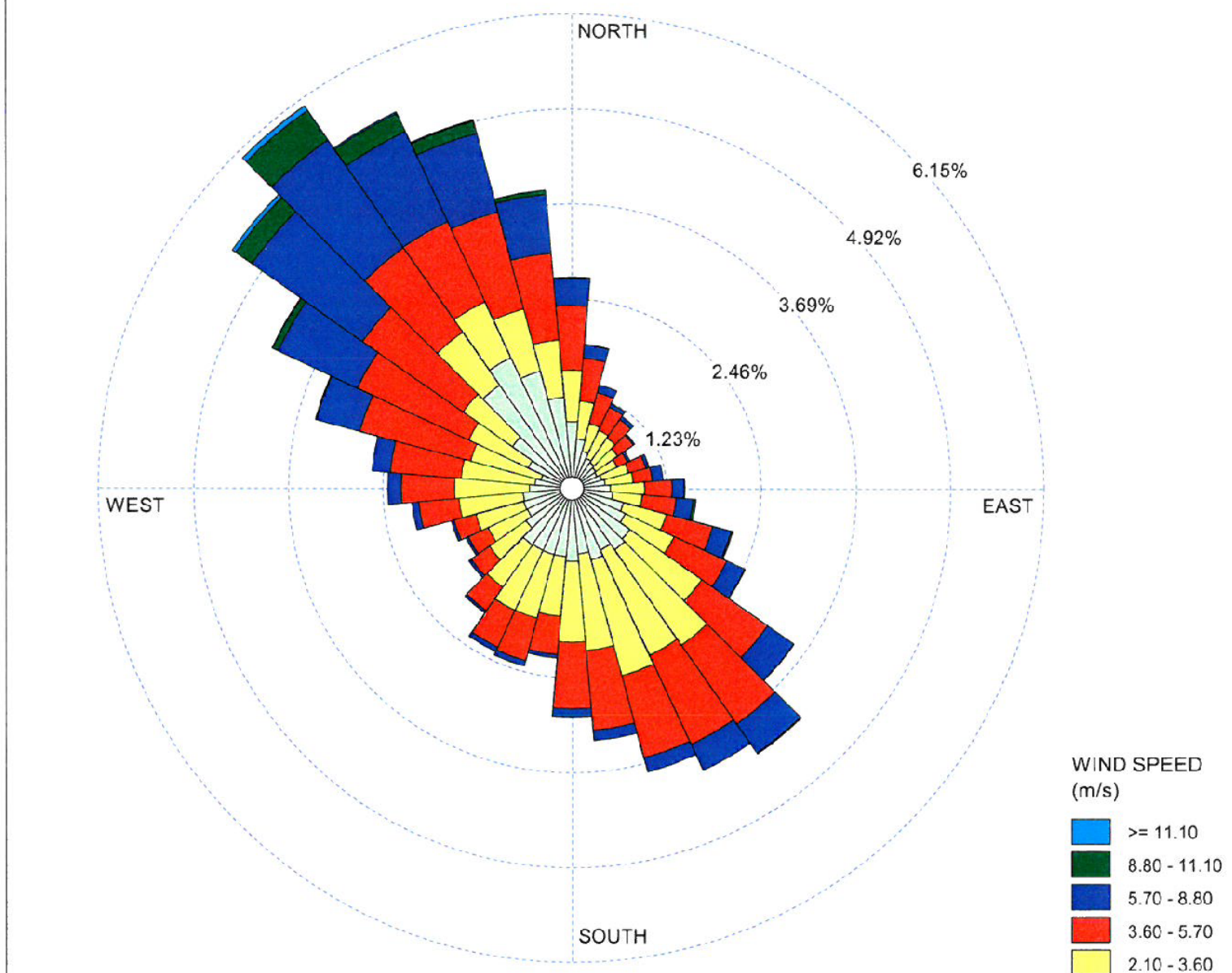
VEGETATIVE AND TERRESTRIAL WILDLIFE NHIS DATA

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019

WIND ROSE PLOT:
Station #94931

DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
Jan 1 to March 31, 2016	**Start Date: 1/1/2012 - 00:00** **End Date: 12/31/2016 - 23:59**	**Foth Infrastructure & Environment, LLC**	
	CALM WINDS: **3.71%**	TOTAL COUNT: **43712 hrs.**	
	AVG. WIND SPEED: **3.37 m/s**	DATE:01/19/2018 **7/18/2019**	PROJECT NO.: **16T777**

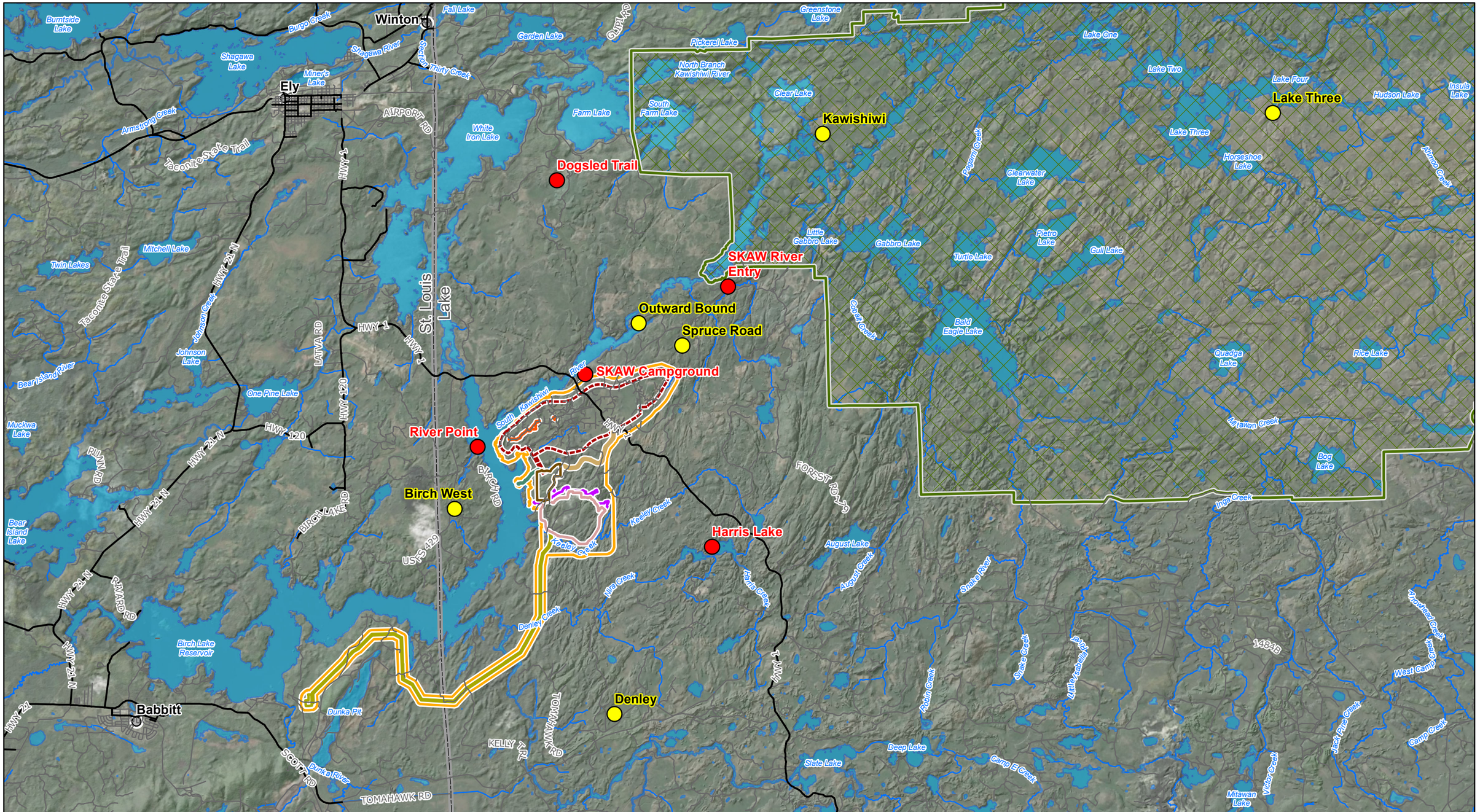
WRPLOT View - Lakes Environmental Software

TWIN METALS MINNESOTA

FIGURE 3-28

WIND ROSE

Scale: Not to Scale | Date: 09/24/2019



NOTES:

1. Base air photo from Esri World Imagery map service.
2. Project related facilities supplied by Twin Metals Minnesota.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Ambient Noise Measurements taken Jan-Mar
- Ambient Noise Measurements taken April - Oct
- Primary Road
- Secondary Road
- Place Name
- River/Stream
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor
- Lake/Pond
- County Boundary
- Boundary Waters Canoe Area Wilderness
- Project Area
- Underground Mine Area

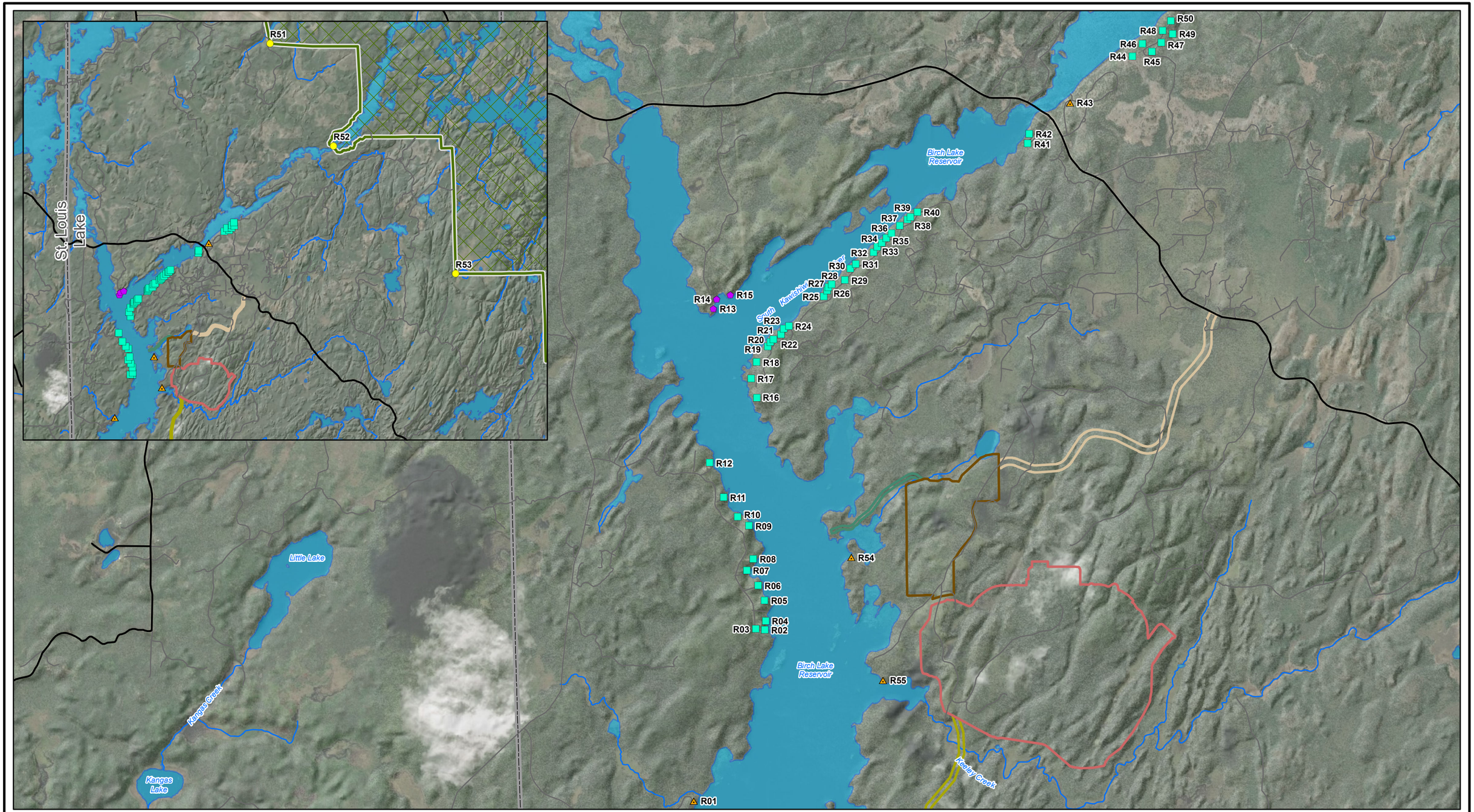
TWIN METALS MINNESOTA

FIGURE 3-29

U.S. FOREST SERVICE
AMBIENT NOISE MEASUREMENT LOCATIONS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from Esri World Imagery map service.
2. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).
3. Noise Receptors were supplied by HEI.

LEGEND

- Boundary Waters
- Recreation
- Residence
- Resort
- Primary Road
- Secondary Road
- Place Name
- River/Stream
- Plant Site
- Tailings Management Site
- Transmission Corridor
- Water Intake Corridor
- Access Road Corridor
- Lake/Pond
- County Boundary
- Boundary Waters Canoe Area Wilderness

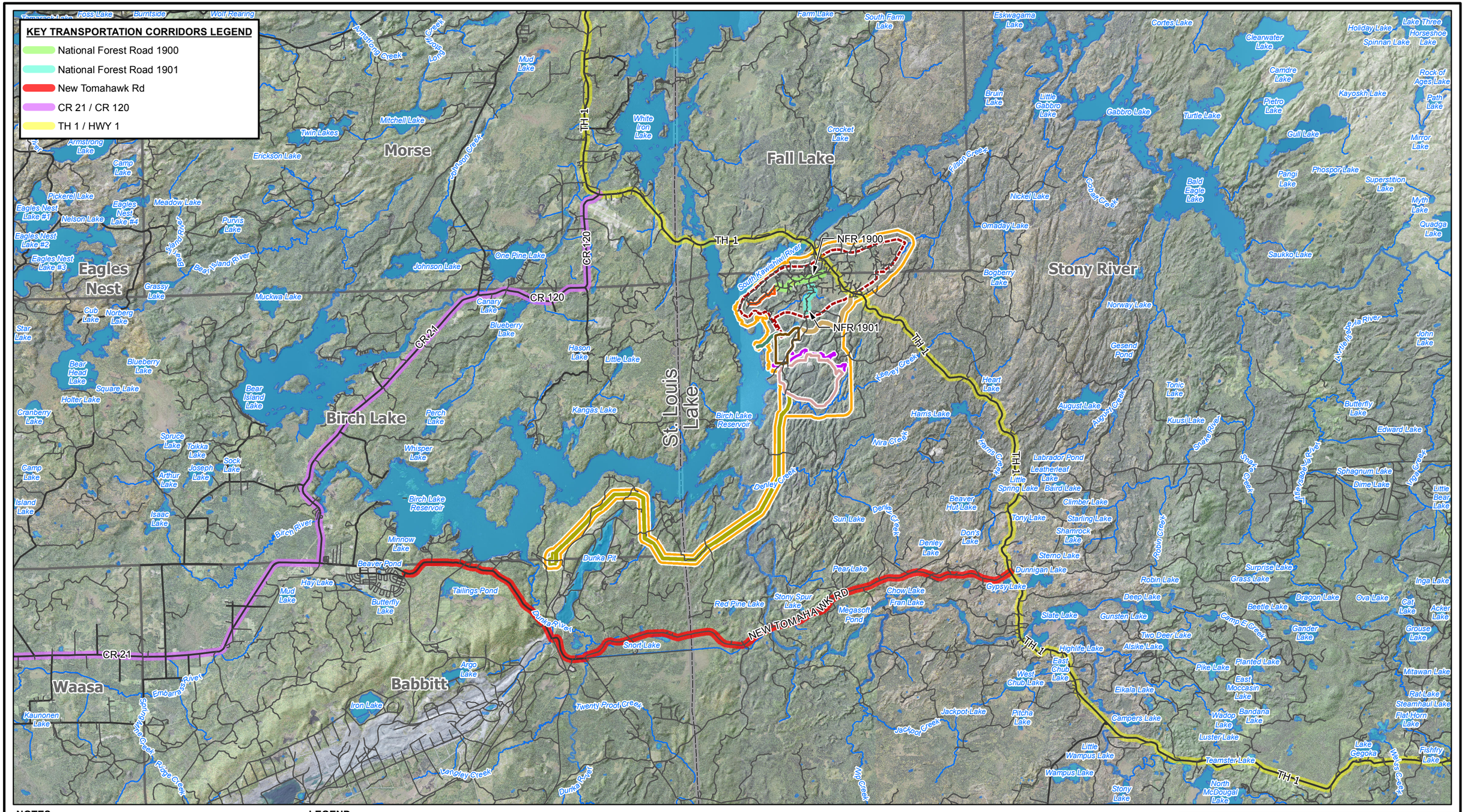
TWIN METALS MINNESOTA

FIGURE 3-30

SENSITIVE RECEPTORS - NOISE

Scale: 0 0.25 0.5 Miles

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area

TWIN METALS MINNESOTA

FIGURE 3-31

KEY TRANSPORTATION CORRIDORS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019

APPENDICES

APPENDIX A

MINERAL AND SURFACE OWNERSHIP INFORMATION

Document No. TMM-LA-025-0001 Rev 0A

December 18, 2019

To Whom It May Concern:

The attached figures and table provide an overview of Twin Metals Minnesota LLC's (TMM's) interest in the surface lands and minerals within the Twin Metals Minnesota Project (Project) area.

Figure 1, Figure 1-1, Figure 1-2, and Figure 1-3 show the current surface ownership within the Project area. Figure 2, Figure 2-1, Figure 2-2, and Figure 2-3 show the current mineral ownership within the Project area. Table 1 provides additional details regarding ownership for both surface and mineral resources.

Information in Table 1 is organized by Township, Range, Section, Quarter Section, and Quarter-Quarter Section (or government lot) land survey boundaries. The geographic boundaries, as well as landowner and taxpayer information, are sourced from the October 2018 St. Louis and Lake Counties, Minnesota parcel data. Updates to the St. Louis and Lake Counties data are provided where TMM is aware of additional information that is not reflected in the St. Louis and Lake Counties GIS database. Acreages identified in Table 1 reflect surface and mineral ownership, and *do not* reflect Project-related disturbance. Project-related disturbance is discussed in the *Mine Plan of Operations, Twin Metals Minnesota Project* dated December 18, 2019.

Attached:
Figure 1: Current Surface Ownership
Figure 1-1: Current Surface Ownership Area 1
Figure 1-2: Current Surface Ownership Area 2
Figure 1-3: Current Surface Ownership Area 3
Figure 2: Current Mineral Ownership
Figure 2-1: Current Mineral Ownership Area 1
Figure 2-2: Current Mineral Ownership Area 2
Figure 2-3: Current Mineral Ownership Area 3
Table 1: Surface and Mineral Ownership Information for Project Area

Sincerely,

Twin Metals Minnesota LLC

CURRENT SURFACE OWNERSHIP
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 1

County
Township
Section
Lakes
Rivers & Streams

Surface Ownership
County
USA
State
Private

N

NOTES:

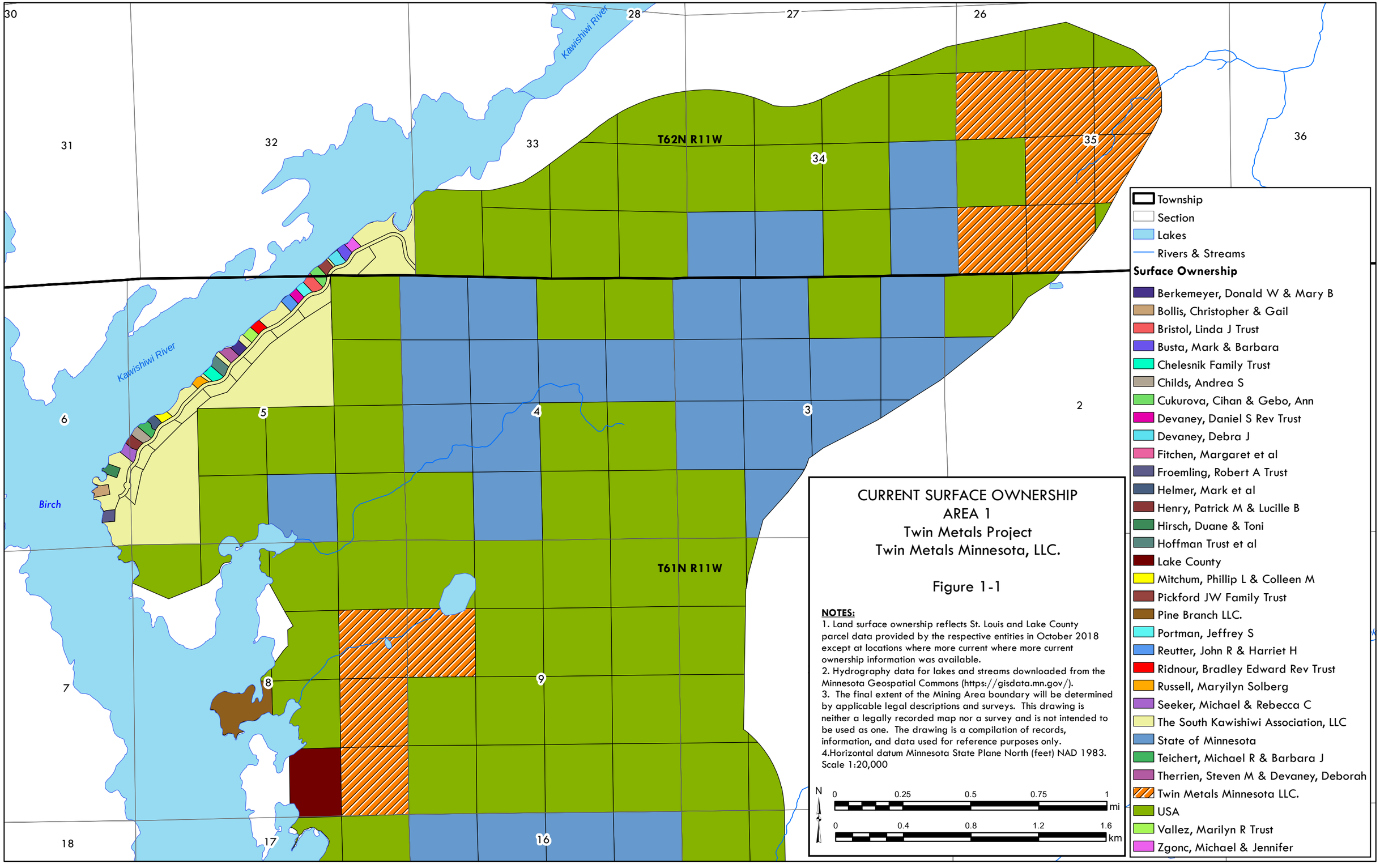
1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983. Scale 1:60,000

0 1 2 3 Miles
0 1 2 3 4 5 km

See Fig. 1-1
See Fig. 1-2
See Fig. 1-3

T62N R11W
T61N R11W
T61N R12W
T61N R13W
T60N R11W
T60N R12W
T60N R13W

Kawishiwi River
Keeley Creek
Kenagas Creek
Nina Creek
Denley Creek
Birch River
Birch Lake
Dunka River
Stony River



CURRENT SURFACE OWNERSHIP
AREA 1
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 1-1

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:20,000

N

0 0.25 0.5 0.75 1 mi

0 0.4 0.8 1.2 1.6 km

CURRENT SURFACE OWNERSHIP
AREA 2
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 1-2

N

County
Township
Section
Lakes
Rivers & Streams

Surface Ownership

State of Minnesota
USA

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:20,000

0 0.1 0.2 0.4 0.6 0.8 1 mi

0 0.3 0.6 0.9 1.2 1.5 km

18 17 16 15 14

19 20 21 22

25 30 29 28 27

36 31 32 33 34

T61N R11W

Keeley Creek

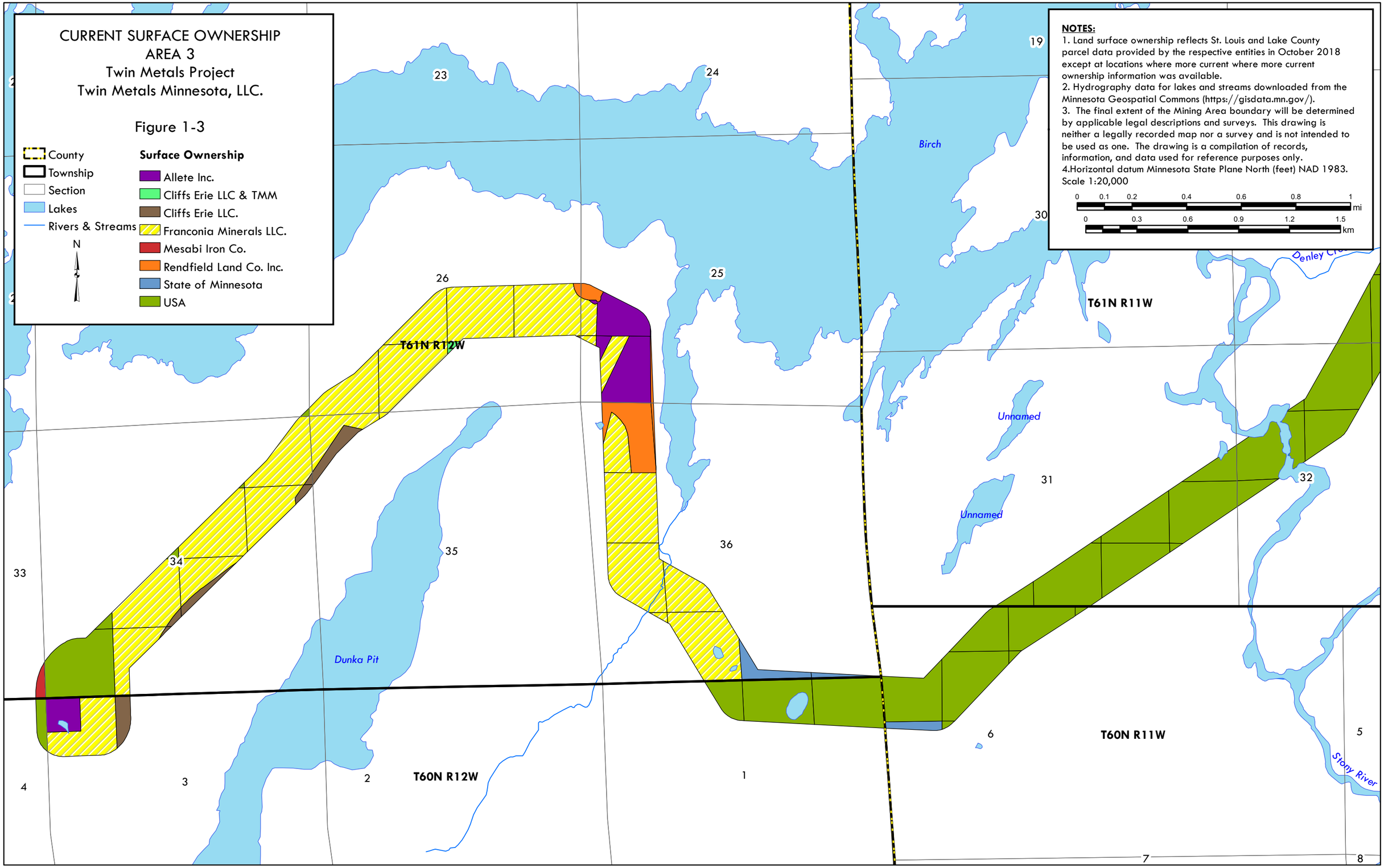
Birch

Nira Creek

Stony River

Denley Creek

Unnamed


CURRENT SURFACE OWNERSHIP
AREA 3
Twin Metals Project
Twin Metals Minnesota, LLC.
Figure 1-3
County
Township
Section
Lakes
Rivers & Streams
N
Surface Ownership
Allete Inc.
Cliffs Erie LLC & TMM
Cliffs Erie LLC.
Franconia Minerals LLC.
Mesabi Iron Co.
Rendfield Land Co. Inc.
State of Minnesota
USA
NOTES:
1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4.Horizontal datum Minnesota State Plane North (feet) NAD 1983.
Scale 1:20,000
0 0.1 0.2 0.4 0.6 0.8 1 mi
0 0.3 0.6 0.9 1.2 1.5 km
T61N R12W
T61N R11W
T60N R12W
T60N R11W
Birch
Unnamed
Unnamed
Dunka Pit
Stony River
19
23
24
25
26
30
31
32
33
34
35
36
1
2
3
4
5
6
7
8

CURRENT MINERAL OWNERSHIP
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 2

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:60,000

County
Township
Section
Lakes
Rivers & Streams

Mineral Ownership

Allete Inc.
DRM/KMK/Dunka
Du Nord/Worthen/et al
Foster/Maki/et al
Franconia/Hector Iron Co.
Longyear Mesaba
Mesabi Iron Co.
RGGS Land & Minerals
Rendrag Inc.
St. Croix/USA
State of MN
State/DRM/KMK/Dunka
State/St. Croix
USA
Woodbury et al

N

0 1 2 3 Miles
0 1 2 3 km

See Fig. 2-1
See Fig. 2-2
See Fig. 2-3

T62N R11W
T61N R13W
T61N R12W
T61N R11W
T60N R13W
T60N R12W
T60N R11W

Kawishiwi River
Bear Island River
Blueberry Lake Outlet
Kanaas Creek
Keeley Creek
Nira Creek
Denley Creek
Birch River
Birch Lake
Dunka River
Stony River

Township
Section
Lakes
Rivers & Streams

Mineral Ownership

- Foster/Maki/et al
- Franconia/Hector Iron Co.
- RGGS Land & Minerals
- St. Croix/USA
- State of MN
- State/St. Croix
- USA

T62N R11W

T61N R11W

Kawishiwi River

Birch

30 28 27 26 32 33 34 35 36 6 5 4 3 2 1 7 8 9 10 18 17 16 15

CURRENT MINERAL OWNERSHIP
AREA 1
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 2-1

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:20,000

N

0 0.25 0.5 0.75 1 mi

0 0.4 0.8 1.2 1.6 km

CURRENT MINERAL OWNERSHIP
AREA 2
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 2-2

County
Township
Section
Lakes
Rivers & Streams

Mineral Ownership

St. Croix/USA
State of MN
State/St. Croix
USA

N

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:20,000

0 0.1 0.2 0.4 0.6 0.8 1 mi

0 0.3 0.6 0.9 1.2 1.5 km

T61N R12W

T61N R11W

Birch

Keeley Creek

Nira Creek

Stony River

Denley Creek

14 15 16 17 19 20 21 22 24 25 27 28 29 30 31 32 33 34 36

CURRENT MINERAL OWNERSHIP
AREA 3
Twin Metals Project
Twin Metals Minnesota, LLC.

Figure 2-3

- County
- Township
- Section
- Lakes
- Rivers & Streams

Mineral Ownership

- Allete Inc.
- DRM/KMK/Dunka
- Du Nord/Worthen/et al
- Longyear Mesaba
- Mesabi Iron Co.
- Rendrag Inc.
- State of MN
- State/DRM/KMK/Dunka
- USA
- Woodbury et al

NOTES:

1. Land surface ownership reflects St. Louis and Lake County parcel data provided by the respective entities in October 2018 except at locations where more current where more current ownership information was available.
2. Hydrography data for lakes and streams downloaded from the Minnesota Geospatial Commons (https://gisdata.mn.gov/).
3. The final extent of the Mining Area boundary will be determined by applicable legal descriptions and surveys. This drawing is neither a legally recorded map nor a survey and is not intended to be used as one. The drawing is a compilation of records, information, and data used for reference purposes only.
4. Horizontal datum Minnesota State Plane North (feet) NAD 1983.

Scale 1:20,000

0 0.1 0.2 0.4 0.6 0.8 1 mi

0 0.3 0.6 0.9 1.2 1.5 km

N

T61N R12W

T61N R11W

T60N R12W

T60N R11W

Dunka Pit

Unnamed

Unnamed

Stony River

23 24 25 26 31 32 33 34 35 36 1 2 3 4 5 6 7 8

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

PARCELID	SECTION	TOWNSHIP	RANGE	LEGAL	SURFACE OWNER	MAJORITY MINERAL OWNER	MINOR MINERAL OWNERS	GIS ACRES
20-6011-06310	6	60	11	GOVT LOT 4	USA	USA		0.585
20-6011-06983	6	60	11	GOVT LOT 5	USA	USA		17.415
20-6011-06984	6	60	11	GOVT LOT 6	USA	USA		14.502
20-6011-06986	6	60	11	GOVT LOT 8	USA	USA		23.748
20-6011-06987	6	60	11	GOVT LOT 9	USA	STATE OF MINNESOTA		26.379
20-6011-06988	6	60	11	GOVT LOT 10	USA	STATE OF MINNESOTA		0.699
20-6011-06990	6	60	11	GOVT LOT 16	USA	UNCLEAR: STATE OF MN?		0.533
20-6011-06991	6	60	11	GOVT LOT 17	STATE OF MINNESOTA	UNCLEAR: STATE OF MN?		3.968
20-6111-02250	2	61	11	GOVT LOT 3	USA	USA		8.548
20-6111-02310	2	61	11	GOVT LOT 4	USA	USA		35.712
20-6111-02370	2	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		8.517
20-6111-03010	3	61	11	GOVT LOT 1	STATE OF MINNESOTA	STATE OF MINNESOTA		34.279
20-6111-03070	3	61	11	GOVT LOT 2	USA	USA		38.292
20-6111-03130	3	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.99
20-6111-03190	3	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		30.964
20-6111-03250	3	61	11	GOVT LOT 3	STATE OF MINNESOTA	STATE OF MINNESOTA		36.042
20-6111-03310	3	61	11	GOVT LOT 4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.072
20-6111-03370	3	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.176
20-6111-03430	3	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.352
20-6111-03490	3	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.725
20-6111-03550	3	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.219
20-6111-03610	3	61	11	SW 1/4 OF SW 1/4	USA	USA		40.113
20-6111-03670	3	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		19.662
20-6111-03730	3	61	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		2.191
20-6111-03790	3	61	11	NW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		21.69
20-6111-04010	4	61	11	GOVT LOT 1	USA	USA		36.381
20-6111-04070	4	61	11	GOVT LOT 2	USA	USA		36.033
20-6111-04130	4	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.884
20-6111-04190	4	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		36.677
20-6111-04250	4	61	11	GOVT LOT 3	STATE OF MINNESOTA	STATE OF MINNESOTA		37.135
20-6111-04310	4	61	11	GOVT LOT 4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.764
20-6111-04370	4	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.942
20-6111-04430	4	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.685
20-6111-04490	4	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.354
20-6111-04550	4	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.068
20-6111-04610	4	61	11	SW 1/4 OF SW 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)	40
20-6111-04670	4	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.551
20-6111-04730	4	61	11	NE 1/4 OF SE 1/4	USA	USA		40.481
20-6111-04790	4	61	11	NW 1/4 OF SE 1/4	USA	USA		40.199
20-6111-04850	4	61	11	SW 1/4 OF SE 1/4	USA	USA		40.333
20-6111-04910	4	61	11	SE 1/4 OF SE 1/4	USA	USA		40.256
20-6111-05010	5	61	11	GOVT LOT 1	USA	USA		38.149
20-6111-05190	5	61	11	SE 1/4 OF NE 1/4	USA	USA		39.116
20-6111-05490	5	61	11	NE 1/4 OF SW 1/4	USA	USA		39.728
20-6111-05670	5	61	11	SE 1/4 OF SW 1/4	USA	USA		37.519
20-6111-05730	5	61	11	NE 1/4 OF SE 1/4	USA	USA		40.235
20-6111-05790	5	61	11	NW 1/4 OF SE 1/4	USA	USA		40.151
20-6111-05850	5	61	11	SW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		37.744

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

20-6111-05910	5	61	11	SE 1/4 OF SE 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)	40.293
20-6178-00020	5	61	11	OUTLOT B	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.214
20-6178-00030	5	61	11	OUTLOT C	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.771
20-6178-00040	5	61	11	OUTLOT D	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.73
20-6178-00050	5	61	11	OUTLOT E	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.303
20-6178-00060	5	61	11	OUTLOT F	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.643
20-6178-00080	5	61	11	OUTLOT H	SOUTH KAWISHIWI ASSOCIATION LLC	USA		65.553
20-6178-00090	5	61	11	OUTLOT I	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.944
20-6178-00100	5	61	11	OUTLOT J	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.038
20-6178-00110	5	61	11	OUTLOT K	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.089
20-6178-00120	5	61	11	OUTLOT L	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.636
20-6178-00130	5	61	11	OUTLOT M	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3
20-6178-00140	5	61	11	OUTLOT N	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.28
20-6178-00150	5	61	11	OUTLOT O	SOUTH KAWISHIWI ASSOCIATION LLC	USA		3.604
20-6178-00160	5	61	11	OUTLOT P	SOUTH KAWISHIWI ASSOCIATION LLC	USA		2.872
20-6178-00170	5	61	11	OUTLOT Q	SOUTH KAWISHIWI ASSOCIATION LLC	USA		4.342
20-6178-00180	5	61	11	OUTLOT R	SOUTH KAWISHIWI ASSOCIATION LLC	USA		63.415
20-6178-01050	5	61	11	LOT 5 BLOCK 1	CUKUROVA CIHAN + GEBO ANN	USA		1.653
20-6178-01060	5	61	11	LOT 6 BLOCK 1	BRISTOL LINDA J TRUST 1/24/10	USA		1.631
20-6178-01070	5	61	11	LOT 7 BLOCK 1	PORTMAN JEFFREY S	USA		1.062
20-6178-01080	5	61	11	LOT 8 BLOCK 1	DEVANEY DANIEL S REV TRUST	USA		0.932
20-6178-01090	5	61	11	LOT 9 BLOCK 1	REUTTER JOHN R & HARRIET H	USA		1.324
20-6178-01100	5	61	11	LOT 10 BLOCK 1	RIDNOUR BRADLEY EDWARD REV TRUST	USA		1.028
20-6178-01110	5	61	11	LOT 11 BLOCK 1	VALLEZ MARILYN R TRUST 12/2/88	USA		1.097
20-6178-01120	5	61	11	LOT 12 BLOCK 1	BERKEMEYER DONALD W & MARY B	USA		1.061
20-6178-01130	5	61	11	LOT 13 BLOCK 1	THERRIEN STEVEN M & DEVANEY DEBORAH	USA		1.414
20-6178-01140 and 20-6178-01141	5	61	11	1/2 INTEREST (EACH OWN) LOT 14 BLOCK 1	HOFFMAN FAMILY REAL ESTATE TRUST AND HOFFMAN TRUST ET AL	USA		1.657
20-6178-01150	5	61	11	LOT 15 BLOCK 1	CHELESNIK FAMILY TRUST	USA		1.418
20-6178-01160	5	61	11	LOT 16 BLOCK 1	RUSSELL MARILYN SOLBERG	USA		0.94
20-6178-01170	5	61	11	LOT 17 BLOCK 1	MITCHUM PHILLIP L & COLLEEN M	USA		0.879

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

20-6178-01180 and 20-6178-01181 and 20-6178-01182	5	61	11	LOT 18 BLOCK 1 - 1/3 UDI (each own)	HELMER MARK AND CLARK RICHARD C AND JOHNSON JEANINE ET AL	USA		0.955
20-6178-01190	5	61	11	LOT 19 BLOCK 1	TEICHERT MICHAEL R & BARBARA J	USA		1.245
20-6178-01200	5	61	11	LOT 20 BLOCK 1	CHILDS ANDREA S	USA		1.5
20-6178-01210	5	61	11	LOT 21 BLOCK 1	HENRY PATRICK M & LUCILLE B	USA		1.232
N/A	5	61	11	Road right of way	The South Kawishiwi Association, LLC	USA		13.165
20-6178-00070	6	61	11	OUTLOT G	SOUTH KAWISHIWI ASSOCIATION LLC	USA		8.715
20-6178-01230	6	61	11	LOT 23 BLOCK 1	HIRSCH DUANE C & TONI L	USA		1.274
20-6178-01240	6	61	11	LOT 24 BLOCK 1	BOLLIS CHRISTOPHER J & GAIL M	USA		1.392
20-6178-01250	6	61	11	LOT 25 BLOCK 1	FROEMLING ROBERT A TRUST #12-12 +	USA		1.247
20-6111-07010	7	61	11	GOVT LOT 1	USA	USA		1.78
20-6111-07011	7	61	11	GOVT LOT 12	USA	USA		0.001
20-6111-08010	8	61	11	NE 1/4 OF NE 1/4	USA	Goldie I. Foster; a/k/a Goldie I. Parker; a/k/a Goldie I. Mayer; and Walter B. Foster (17/81)	Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)	40.695
20-6111-08070	8	61	11	NW 1/4 OF NE 1/4	USA	USA		37.278
20-6111-08130	8	61	11	SW 1/4 OF NE 1/4	USA	USA		33.747
20-6111-08190	8	61	11	SE1/4 OF NE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.457
20-6111-08250	8	61	11	GOVT LOT 1	USA	USA		8.937
20-6111-08310	8	61	11	GOVT LOT 2	USA	USA		27.191
20-6111-08430	8	61	11	GOVT LOT 4	USA	USA		0.759
20-6111-08490	8	61	11	LOT 5	PINE BRANCH LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	16.312
20-6111-08730	8	61	11	NE1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.218
20-6111-08790	8	61	11	NW 1/4 OF SE 1/4	USA	USA		31.46
20-6111-08850	8	61	11	SW 1/4 OF SE 1/4	LAKE COUNTY	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	29.269
20-6111-08910	8	61	11	SE1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	39.98
20-6111-09010	9	61	11	NE 1/4 OF NE 1/4	USA	USA		40.065
20-6111-09070	9	61	11	NW 1/4 OF NE 1/4	USA	USA		40.016
20-6111-09130	9	61	11	SW 1/4 OF NE 1/4	USA	USA		40.05
20-6111-09190	9	61	11	SE 1/4 OF NE 1/4	USA	USA		40.1
20-6111-09250	9	61	11	NE 1/4 OF NW 1/4	USA	USA		40.169
20-6111-09310	9	61	11	NW 1/4 OF NW 1/4	USA	GOLDIE I. FOSTER; A/K/A GOLDIE I. PARKER; A/K/A GOLDIE I. MAYER; AND WALTER B. FOSTER (17/81)	Richard A. Maki (1/9) Diane J. Manuszak (1/2 of 1/9) Kristina Metheny (1/2 of 1/6 of 17/81) Robert F. Adolfson (1/6 of 17/81) Paula Moser (1/6 of 17/81) Sandra I. Stigar (1/6 of 17/81) Matthew Adolfson (1/6 of 17/81) Robert Rodriguez (1/2 of 1/6 of 17/81) Laura Richert (1/6 of 17/81) Earl C. Hook (2/81) Jean M. Maki (1/9) David A. Maki (1/2 of 1/9) James K. Maki (1/9) Ina Lassi/Lake-Forest Enterprise, Inc. (1/9)	40.151
20-6111-09370	9	61	11	SW1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	40.37
20-6111-09430	9	61	11	SE 1/4 OF NW 1/4	USA	USA		40.236
20-6111-09490	9	61	11	NE 1/4 OF SW 1/4	USA	USA		40.265
20-6111-09550	9	61	11	NW 1/4 OF SW 1/4	USA	USA		40.399
20-6111-09610	9	61	11	SW 1/4 OF SW 1/4	USA	USA		40.429

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

20-6111-09670	9	61	11	SE 1/4 OF SW 1/4	USA	USA		40.294
20-6111-09730	9	61	11	NE 1/4 OF SE 1/4	USA	USA		40.134
20-6111-09790	9	61	11	NW 1/4 OF SE 1/4	USA	USA		40.084
20-6111-09850	9	61	11	SW 1/4 OF SE 1/4	USA	USA		40.118
20-6111-09910	9	61	11	SE 1/4 OF SE 1/4	USA	USA		40.168
20-6111-10250	10	61	11	NE 1/4 OF NW 1/4	USA	USA		2.284
20-6111-10310	10	61	11	NW 1/4 OF NW 1/4	USA	USA		39.863
20-6111-10370	10	61	11	SW 1/4 OF NW 1/4	USA	USA		38.766
20-6111-10490	10	61	11	NE 1/4 OF SW 1/4	USA	USA		0.404
20-6111-10550	10	61	11	NW 1/4 OF SW 1/4	USA	USA		38.129
20-6111-10610	10	61	11	SW 1/4 OF SW 1/4	USA	USA		39.937
20-6111-10670	10	61	11	SE 1/4 OF SW 1/4	USA	USA		16.021
20-6111-15250	15	61	11	NE 1/4 OF NW 1/4	USA	USA		20.834
20-6111-15310	15	61	11	NW 1/4 OF NW 1/4	USA	USA		39.903
20-6111-15370	15	61	11	SW 1/4 OF NW 1/4	USA	USA		39.886
20-6111-15430	15	61	11	SE 1/4 OF NW 1/4	USA	USA		20.845
20-6111-15490	15	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		20.855
20-6111-15550	15	61	11	NW 1/4 OF SW 1/4	USA	USA		39.868
20-6111-15610	15	61	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.85
20-6111-15670	15	61	11	SE 1/4 OF SW 1/4	USA	USA		20.866
20-6111-16010	16	61	11	NE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.126
20-6111-16070	16	61	11	NW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.133
20-6111-16130	16	61	11	SW 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.076
20-6111-16190	16	61	11	SE 1/4 OF NE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.069
20-6111-16250	16	61	11	NE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.215
20-6111-16310	16	61	11	NW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.173
20-6111-16370	16	61	11	SW 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.049
20-6111-16430	16	61	11	SE 1/4 OF NW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.092
20-6111-16490	16	61	11	NE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.027
20-6111-16550	16	61	11	NW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.035
20-6111-16610	16	61	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.978
20-6111-16670	16	61	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.97
20-6111-16730	16	61	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.012
20-6111-16790	16	61	11	NW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		40.019
20-6111-16850	16	61	11	SW 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.962
20-6111-16910	16	61	11	SE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.955
20-6111-17010	17	61	11	NE 1/4 OF NE 1/4	USA	STATE OF MN (1/2)	St. Croix Lumber Co (1/2)	37.299
20-6111-17070	17	61	11	GOVT LOT 1	USA	ST. CROIX LUMBER CO (1/2)	USA	11.701
20-6111-17190	17	61	11	SE 1/4 OF NE 1/4	USA	USA		30.413
20-6111-17730	17	61	11	GOVT LOT 8	USA	USA		29.309
20-6111-17910	17	61	11	SE 1/4 OF SE 1/4	USA	USA		30.409
20-6111-20010	20	61	11	NE 1/4 OF NE 1/4	USA	USA		33.873
20-6111-20070	20	61	11	NW 1/4 OF NE 1/4	USA	USA		1.508
20-6111-20130	20	61	11	SW 1/4 OF NE 1/4	USA	USA		8.6
20-6111-20190	20	61	11	SE 1/4 OF NE 1/4	USA	USA		22.24
20-6111-20730	20	61	11	NE 1/4 OF SE 1/4	USA	USA		19.668
20-6111-20790	20	61	11	NW 1/4 OF SE 1/4	USA	USA		10.749
20-6111-20850	20	61	11	SW 1/4 OF SE 1/4	USA	USA		11.479
20-6111-20910	20	61	11	SE 1/4 OF SE 1/4	USA	USA		18.937
20-6111-21010	21	61	11	NE 1/4 OF NE 1/4	USA	USA		30.789
20-6111-21070	21	61	11	NW 1/4 OF NE 1/4	USA	USA		36.226
20-6111-21250	21	61	11	NE 1/4 OF NW 1/4	USA	USA		30.167
20-6111-21310	21	61	11	NW 1/4 OF NW 1/4	USA	USA		30.161
20-6111-22250	22	61	11	NE 1/4 OF NW 1/4	USA	USA		10.838
20-6111-22310	22	61	11	NW 1/4 OF NW 1/4	USA	USA		29.495
20-6111-29010	29	61	11	NE 1/4 OF NE 1/4	USA	USA		18.149
20-6111-29070	29	61	11	NW 1/4 OF NE 1/4	USA	USA		12.188
20-6111-29130	29	61	11	SW 1/4 OF NE 1/4	USA	USA		13.048
20-6111-29190	29	61	11	SE 1/4 OF NE 1/4	USA	USA		17.394
20-6111-29670	29	61	11	SE 1/4 OF SW 1/4	USA	USA		9.273
20-6111-29730	29	61	11	NE 1/4 OF SE 1/4	USA	USA		7.967
20-6111-29790	29	61	11	NW 1/4 OF SE 1/4	USA	USA		26.6
20-6111-29850	29	61	11	SW 1/4 OF SE 1/4	USA	USA		25.422
20-6111-31190	31	61	11	SE 1/4 OF NE 1/4	USA	USA		8.398
20-6111-31490	31	61	11	GOVT LOT 8	USA	USA		0.292
20-6111-31610	31	61	11	GOVT LOT 12	USA	USA		4.147
20-6111-31670	31	61	11	GOVT LOT 13	USA	USA		27.057
20-6111-31730	31	61	11	NE 1/4 OF SE 1/4	USA	USA		27.288
20-6111-31790	31	61	11	NW 1/4 OF SE 1/4	USA	USA		17.407
20-6111-31850	31	61	11	GOVT LOT 14	USA	USA		18.78
20-6111-31910	31	61	11	GOVT LOT 15	USA	USA		0.532
20-6111-32070	32	61	11	NW 1/4 OF NE 1/4	USA	USA		4.493

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

20-6111-32250	32	61	11	NE 1/4 OF NW 1/4	USA	USA		29.383
20-6111-32310	32	61	11	NW 1/4 OF NW 1/4	USA	USA		0.868
20-6111-32370	32	61	11	SW 1/4 OF NW 1/4	USA	USA		30.674
20-6111-32430	32	61	11	SE 1/4 OF NW 1/4	USA	USA		14.414
20-6111-32550	32	61	11	NW 1/4 OF SW 1/4	USA	USA		4.698
20-6178-01220	5 & 6	61	11	LOT 22 BLOCK 1	SEEKER MICHAEL & REBECCA C	USA		1.473
28-6278-00010	32	62	11	OUTLOT A	SOUTH KAWISHIWI ASSOCIATION LLC	USA		0.205
28-6278-00190	32	62	11	OUTLOT S	SOUTH KAWISHIWI ASSOCIATION LLC	USA		5.007
28-6278-00200	32	62	11	OUTLOT T	SOUTH KAWISHIWI ASSOCIATION LLC	USA		11.807
28-6278-00210	32	62	11	OUTLOT U	SOUTH KAWISHIWI ASSOCIATION LLC	USA		9.324
28-6278-01010	32	62	11	LOT 1 BLOCK 1	ZGONC MICHAEL J & JENNIFER L	USA		1.029
28-6278-01020	32	62	11	LOT 2 BLOCK 1	BUSTA MARK W & BARBARA A	USA		1.137
28-6278-01030	32	62	11	LOT 3 BLOCK 1	DEVANEY DEBRA J	USA		1.325
28-6278-01040	32	62	11	LOT 4 BLOCK 1	PICKFORD JW FAMILY TRUST	USA		1.045
28-6211-33130	33	62	11	GOVT LOT 2	USA	USA		4.99
28-6211-33190	33	62	11	SE1/4 OF NE1/4	USA	USA		26.91
28-6211-33490	33	62	11	GOVT LOT 7	USA	USA		15.651
28-6211-33550	33	62	11	GOVT LOT 6	USA	USA		49.997
28-6211-33670	33	62	11	SE 1/4 OF SW 1/4	USA	RGGS Land & Minerals Ltd LP		40.757
28-6211-33730	33	62	11	NE 1/4 OF SE 1/4	USA	USA		39.67
28-6211-33790	33	62	11	NW 1/4 OF SE 1/4	USA	RGGS Land & Minerals Ltd LP		37.127
28-6211-33850	33	62	11	SW 1/4 OF SE 1/4	USA	USA		40.175
28-6211-33910	33	62	11	SE 1/4 OF SE 1/4	USA	RGGS Land & Minerals Ltd LP		39.384
28-6211-34010	34	62	11	NE 1/4 OF NE 1/4	USA	FRANCONIA MINERALS CORPORATION INC. (1/2)	Hector Iron Co. (1/2)	10.034
28-6211-34070	34	62	11	NW 1/4 OF NE 1/4	USA	FRANCONIA MINERALS CORPORATION INC. (1/2)	Hector Iron Co. (1/2)	0.24
28-6211-34130	34	62	11	SW 1/4 OF NE 1/4	USA	USA		33.857
28-6211-34190	34	62	11	SE 1/4 OF NE 1/4	USA	USA		38.731
28-6211-34370	34	62	11	SW 1/4 OF NW 1/4	USA	USA		31.828
28-6211-34430	34	62	11	SE 1/4 OF NW 1/4	USA	USA		23.993
28-6211-34490	34	62	11	NE 1/4 OF SW 1/4	USA	USA		38.934
28-6211-34550	34	62	11	NW 1/4 OF SW 1/4	USA	USA		38.66
28-6211-34610	34	62	11	SW 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.645
28-6211-34670	34	62	11	SE 1/4 OF SW 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.919
28-6211-34730	34	62	11	NE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		38.889
28-6211-34790	34	62	11	NW 1/4 OF SE 1/4	USA	USA		38.68
28-6211-34850	34	62	11	SW 1/4 OF SE 1/4	USA	USA		38.928
28-6211-34910	34	62	11	SE 1/4 OF SE 1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		39.173
28-6211-35070	35	62	11	NW 1/4 OF NE 1/4	USA	USA		10.157
28-6211-35130	35	62	11	SW1/4 OF NE1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		37.757
28-6211-35250	35	62	11	NE 1/4 OF NW 1/4	USA	USA		25.002
28-6211-35310	35	62	11	NW 1/4 OF NW 1/4	USA	USA		20.265
28-6211-35370	35	62	11	SW1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.037
28-6211-35430	35	62	11	SE1/4 OF NW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.196
28-6211-35490	35	62	11	NE1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.684
28-6211-35550	35	62	11	NW 1/4 OF SW 1/4	USA	USA		40.347
28-6211-35610	35	62	11	SW1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		40.071
28-6211-35670	35	62	11	SE1/4 OF SW1/4	TWIN METALS MINNESOTA LLC	RGGS Land & Minerals Ltd LP		34.599
28-6211-35790	35	62	11	NW1/4 OF SE1/4	TWIN METALS MINNESOTA LLC	RGGS LAND & MINERALS LTD LP		21.677
28-6211-35850	35	62	11	SW 1/4 OF SE 1/4	USA	USA		2.175
105-0060-00010	1	60	12	GOVT LOT 1	USA	Rendrag Inc.		29.23
105-0060-00010	1	60	12	GOVT LOT 2	USA	Longyear Mesaba		25.821
105-0060-00010	1	60	12	GOVT LOT 3	USA	Rendrag Inc.		8.904

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

105-0060-00370	3	60	12	LOT 3	CLIFFS ERIE LLC	DUNKA MINERALS CORP. (1/3)	KMK Dunka Inc. (1/3) DRM Minerals Corp. (1/3)	5.512
105-0060-00380	3	60	12	N 660 FT OF W 660 OF GOVT LOT 4	ALLETE INC	STATE OF MN (1/3)	Dunka Minerals Corp. (2/9) KMK Dunka Inc. (2/9) DRM Minerals Corp. (2/9)	9.997
105-0060-00382	3	60	12	GOVT LOT 4 EX N 660 FT OF W 660 FT	FRANCONIA MINERALS (US) LLC	STATE OF MN (1/3)	Dunka Minerals Corp. (2/9) KMK Dunka Inc. (2/9) DRM Minerals Corp. (2/9)	24.544
105-0060-00490	4	60	12	NE1/4 OF NE1/4	USA	RENDRAG INC.		3.996
610-0011-03620	25	61	12	Government Lot 4, Section 25, Township 61 North, Range 12, EXCEPT that part beginning at a point where the southerly line of Government Lot 4 meets the easterly shoreline of Bobs Bay; thence East 400 feet; thence North 470 feet; thence West 400 feet; thence Southerly to the point of beginning.	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.041
610-0011-03630	25	61	12	That part of the NW1/4 of SW1/4 Section 25 Township 61 North Range 12 West lying SE'ly of the following described "Lines A and B": Commencing at the NW corner of the SE1/4 of NW1/4, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to the point of tangency and the point of beginning of "LIne A": "Line A" - thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft; thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft to the N line of said NW1/4 of SW1/4, Section 25, and there terminating. "Line B" - beginning at the point of beginning of the above designated "Line A"; thence S 02 degrees 31 minutes 39 seconds W a distance of 694.58 ft to the S line of said NW1/4 of SW1/4, and there terminating.	ALLETE INC	DU NORD LAND CO (1/2)	Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)	14.995
610-0011-03631	25	61	12	That part of the NW¼ of SW¼, Section 25 in Township 61 North, Range 12 West lying N'ly, NE'ly and NW'ly of the following described line: Beginning at the NW corner of SE¼ of NW¼, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft.; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft., central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft. to the point of tangency ; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft.; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft., central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft., central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft. to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft.; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft., central angle of 43 degrees 11 minutes 47 seconds , a distance of 251 . 05 ft. to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433. 00 ft., central angle of 22 degrees 33 minutes 42 seconds , a distance of 564.28 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft., central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft., central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft., central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft., central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 feet, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft.; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft.; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft., central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft. to the point of tangency; thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft.; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft., thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft. to the N line of said NW¼ of SW¼, Section 25, and there terminating.	RENDFIELD LAND CO INC	DU NORD LAND CO (1/2)	Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)	2.48

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-03632	25	61	12	That part of the NW1/4 of the SW1/4 lying S'ly and W'ly of the following described line; Commencing at the NW corner of the SE1/4 of NW1/4, Section 26, Township 61 North, Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Tansverse Mercardor 1996 Projection, a distance of 268.32 ft; thence SE'ly along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E, a distance of 486.88 ft; thence SE'ly along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E, a distance of 143.72 ft; thence SE'ly along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft, cetral angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thene SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance of 385.46 ft to the point of beginning of the line to be described; thence continuing SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance of 385.46 ft to the point of beginning of the line to be described; thence continuing SE'ly, along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 24 degrees 29 minutes 10 seconds, a distance of 142.31 ft; thence S 50 degrees 05 minutes 02 seconds E, a distance of 98.03 ft; thence SE'ly along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the S line of said NW1/4 of SW1/4 and said line there terminating.	FRANCONIA MINERALS (US) LLC	DU NORD LAND CO (1/2)	Frederic Paine Worthen/Frederic P. Worthen 1980 Trust (1/22) Anna Welles Paines Williams/Sarah Townsend Williams (1/22) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Roger Townsend Williams (1/60) Geoffrey Paine Williams (1/60) Joel Hooker Williams (1/60) Sarah Townsend Williams (1/60) Susan Barton Williams (1/60) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) State of Minnesota (391/2112)	4.79
610-0011-03640	25	61	12	SW1/4 of SW1/4 Section 25 in Township 61 North Range 12 West of the Fourth Principal Meridian EXCEPT that part of the SW1/4 of SW1/4 Section 25 Township 61 North Range 12 West lying S'ly and W'ly of "Line A" to be described and 300.00 ft NW'ly of, measured at right angles to and parallel with "Line B" to be described. "Line A" and "Line B" are described as follows: "Line A" Commencing at the NW corner of the SE1/4 of NW1/4 Section 26 Township 61 North Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'y along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, cental angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve, thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to a point; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the N line of said SW1/4 of SW1/4 and also being the point of beginning of the line to be decribed; thence continuing S 02 degrees 31 minutes 39 seconds W, a distance of 256.53 ft; thence SW'ly along a tangential curve concave to the NW having a radius of 1134.00 ft, central angle of 30 degrees 15 minutes 34 seconds, a distance of 598.90 ft to the point of reverse curve; thence SW'ly, S'ly and SE'ly, along said reverse curve concave to the E having a radius of 333.00 ft, cental angle of 60 degrees 16 minutes 05 seconds, a distance of 350.27 ft to a point being 300.00 ft NW'ly of, measured at right angles to and parallel with "Line B" to be described and said "Line A" there terminating. "Line B" Commencing at the SW corner of said Section 25; thence S 88 degrees 33 minutes 39 seconds E along the S line of said Section 25, a distance of 334.90 ft to the beginning of the line to be described; thence N 14 degrees 59 minutes 50 seconds E, a distance of 70.97 ft; thence N 26 degrees 29 minutes 50 seconds E, a distance of 1393.23 ft to the N line of said SW1/4 of SW1/4 and said "Line B" there terminating. The side line of said 300.00 ft wide strip terminates on said "Line A" and the S line of said SW1/4 of SW1/4. SE1/4 of SE1/4 Section 35 in Township 61 North Range 12 West of the Fourth Principal Meridian.	ALLETE INC	USA		22.881

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-03641	25	61	12	That part of the SW1/4 of SW1/4, Section 25, Township 61 North, Range 12 West, lying S'ly and W'ly of "Line A" to be described and 300.00 ft NW'ly of, measured at right angles to and parallel with "Line B" to be described. "Line A" and "Line B" are described as follows: "Line A" Commencing at the NW corner of the SE1/4 of NW1/4, Section 26, Township 61 North, Range 12 West; thence S 76 degrees 38 minutes 05 seconds E bearing based on Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433.00 ft, central angle of 22 degrees 33 minutes 42 seconds, a distance of 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve, thence SE'ly along said reverse curve concave to the NE having a radius of 33.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft to the point of compound curvature; thence SE'ly, along said compund curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft, central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft to a point; thence S 02 degrees 31 minutes 39 seconds W, a distance of 694.58 ft to the N line of said SW1/4 of SW1/4 and also being the point of beginning of the line to be described; thence continuing S 02 degrees 31 minutes 39 seconds W, a distance of 256.53 ft; thence SW'ly, along a tangential curve concave to the NW having a radius of 1134.00 ft, central angle of 30 degrees 15 minutes 34 seconds, a distance of 598.90 ft to the point of reverse curve; thence SW'ly, S'ly and SE'ly, along said reverse curve concave to the E having a radius of 333.00 ft, central angle of 60 degrees 16 minutes 05 seconds, a distance of 350.27 ft to a point being 300.00 ft NW'ly of, measured at right angles to and parallel with "Line B" to be described and said "Line A" there terminating. "Line B" Commencing at the SW corner of said Section 25; thence S 88 degrees 33 minutes 39 seconds E along the S line of said Section 25, a distance of 334.90 ft to the beginning of the line to be described; thence N 14 degrees 59 minutes 50 seconds E, a distance of 70.97 ft; thence N 26 degrees 29 minutes 50 seconds E, a distance of 1393.23 ft to the N line of said SW1/4 of SW1/4 and said "Line B" there terminating. The side line of said 300.00 ft wide strip terminates on said "Line A" and the S line of said SW1/4 of SW1/4.	FRANCONIA MINERALS (US) LLC	USA		6.911
610-0011-03650	25	61	12	SE1/4 OF SW 1/4	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.971
610-0011-03740	26	61	12	NE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		16.208
610-0011-03760	26	61	12	SW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		20.88
610-0011-03770	26	61	12	SE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		25.9
610-0011-03780	26	61	12	That part of the NE1/4 of the SE1/4 lying S'ly and SW'ly ofthe following described line: Beginning at the NW corner of the SE1/4 of NW1/4, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on St Louis County Transverse Mercardor 1996 Projection, a distance of 268.32 ft; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft, central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft to the point of tangency; thence N 87 degrees 24 minutes 03 seconds E, a distance of 486.88 ft; thence SE'ly along a tangential curve concave to the S having a radius of 1734.00 ft, central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft, central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E, a distance of 143.72 ft; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft, central angle of 43 degrees 11 minutes 47 seconds, a distance of 251.05 ft to the point of compound curvature; thence NE'ly along said compound curve concave to the NW having a radius of 1433.00 ft; central angle of 22 degrees 33 minutes 42 seconds, a distance 564.28 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 267.00 ft, central angle of 61 degrees 17 minutes 17 minutes 29 seconds, a distance of 285.62 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the SW having a radius of 1600.00 ft, central angle of 30 degrees 23 minutes 54 seconds, a distance 848.88 ft to the point of compound curvature; thence SE'ly along said compound curve concave to the SW having a radius of 267.00 ft, central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft to the point of reverse curve; thence SE'ly along said reverse curve concave to the NE having a radius of 333.00 ft, central angle of 66 degrees 19 minutes 22 seconds, a distance 385.46 ft to the E line of said NE1/4 of SE1/4 and said line there terminating.	FRANCONIA MINERALS (US) LLC	DU NORD LAND CO (1/2)	Emilie WashburnWorthen Hall (1/32) John Stuart Paine (1/32) Thomas H. Paine (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) Frederic Paine Worthen (1/22) Anna Welles Paines Williams (1/22) Rebecca Paine Field (1/22) Mary Paine Worthen (1/22) Mary Worthen Morton (1/22) State of Minnesota (391/2112)	29.118

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-03781	26	61	12	That part of the NE¼ of SE¼, Section 26, in Township 61 North, Range 12 West lying N'ly, NE'ly and NW'ly of the following described line: Beginning at the NW corner of SE¼ of NW¼, said Section 26; thence S 76 degrees 38 minutes 05 seconds E bearing based on the Saint Louis County Transverse Mercador 1996 Projection, a distance of 268.32 ft.; thence SE'ly, along a non-tangential curve concave to the NE having a radius of 50.00 ft., central angle of 81 degrees 41 minutes 24 seconds (chord bearing of S 51 degrees 45 minutes 17 seconds E), a distance of 71.29 ft. to the point of tangency ; thence N 87 degrees 24 minutes 03 seconds E a distance of 486.88 ft.; thence SE'ly, along a tangential curve concave to the S having a radius of 1734.00 ft., central angle of 16 degrees 03 minutes 24 seconds, a distance of 485.94 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 717.00 ft., central angle of 37 degrees 33 minutes 26 seconds, a distance of 469.99 ft. to the point of tangency; thence S 38 degrees 59 minutes 07 seconds E a distance of 143.72 ft.; thence SE'ly, along a tangential curve concave to the NE having a radius of 333.00 ft., central angle of 43 degrees 11 minutes 47 seconds , a distance of 251 . 05 ft. to the point of compound curvature; thence NE'ly, along said compound curve concave to the NW having a radius of 1433. 00 ft., central angle of 22 degrees 33 minutes 42 seconds , a distance of 564.28 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 267.00 ft., central angle of 61 degrees 17 minutes 29 seconds, a distance of 285.62 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 ft., central angle of 32 degrees 25 minutes 27 seconds, a distance of 188.45 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the SW having a radius of 1600.00 ft., central angle of 30 degrees 23 minutes 54 seconds, a distance of 848.88 ft. to the point of compound curvature; thence SE'ly, along said compound curve concave to the SW having a radius of 267.00 ft., central angle of 51 degrees 58 minutes 24 seconds, a distance of 242.20 ft. to the point of reverse curve; thence SE'ly, along said reverse curve concave to the NE having a radius of 333.00 feet, central angle of 90 degrees 48 minutes 32 seconds, a distance of 527.78 ft.; thence S 50 degrees 05 minutes 02 seconds E a distance of 98.03 ft.; thence SE'ly, along a tangential curve concave to the N having a radius of 70.00 ft., central angle of 81 degrees 17 minutes 29 seconds, a distance of 99.32 ft. to the point of tangency; thence N 48 degrees 37 minutes 29 seconds E a distance of 90.93 ft.; thence N 00 degrees 00 minutes 00 seconds W a distance of 66.00 ft., thence N 28 degrees 00 minutes 12 seconds E a distance of 568.9 ft. to the N line of said NW¼ of SW¼, Section 25, and there terminating.	RENDFIELD LAND CO INC	DU NORD LAND CO (1/2)	Emilie WashburnWorthen Hall (1/32) John Stuart Paine (1/32) Thomas H. Paine (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo Rebecca Paine Fields (1/32) U.S. Bank N.A., Trustee of F. Rodney Paine Article VI Trust U/W fbo John S. Paine (1/32) Thomas H. Paine, Jr. (1/32) Mary T. Morton Revocable Trust/Jane M. Fetter and Barbara D. Morton (3/64) Frederic Paine Worthen (1/22) Anna Welles Paines Williams (1/22) Rebecca Paine Field (1/22) Mary Paine Worthen (1/22) Mary Worthen Morton (1/22) State of Minnesota (391/2112)	0.634
610-0011-03790	26	61	12	NW 1/4 OF SE 1/4	FRANCONIA MINERALS (US) LLC	ALLETE INC		30.063
610-0011-03800 and 610-0011-03801	26	61	12	That part of the SW¼ of SE¼ Section 26 Township 61 North Range 12 West lying westerly, northwesterly and northerly of the following described line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence South 71 degrees 44 minutes 20 seconds West, bearing based on the east line of said Section 9 having a bearing of South 03 degrees 27 minutes 19 seconds East, St Louis County Transverse Mercator 1996 projection a distance of 462.67 feet; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears North 22 degrees 35 minutes 37 seconds West a distance of 2378.47 feet to the point of tangency; thence North 23 degrees 59 minutes 36 seconds East a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds a distance of 280.81 feet to the point of tangency; thence North 37 degrees 12 minutes 41 seconds East a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds a distance of 2168.30 feet to the point of tangency; thence North 04 degrees 21 minutes 02 seconds East a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds a distance of 2463.58 feet to the point of tangency; thence North 53 degrees 35 minutes 54 seconds East a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds a distance of 63.66 feet to the point of tangency; thence North 57 degrees 36 minutes 21 seconds East a distance of 1469.17 feet; thence North 32 degrees 23 minutes 39 seconds West a distance of 200 feet; thence North 06 degrees 23 minutes 50 seconds West a distance of 482.88 feet; thence North 34 degrees 17 minutes 24 seconds East a distance of 1692.54 feet; thence South 77 degrees 26 minutes 00 seconds East a distance of 1541.34 feet; thence North 52 degrees 08 minutes 41 seconds East a distance of 670.95 feet to the point of beginning of the line to be described; thence continuing North 52 degrees 08 minutes 41 seconds East a distance of 783.84 feet; thence North 68 degrees 02 minutes 16 seconds East a distance of 148.61 feet; thence North 50 degrees 50 minutes 08 seconds East a distance of 328.73 feet; thence North 41 degrees 52 minutes 40 seconds East a distance of 385.23 feet to the east line of said SW¼-SE¼ , and there terminating.	CLIFFS ERIE LLC AND TWIN METALS MN LLC.	PETER WOODBURY (3/4)	DUNKA MINERALS CORP. (1/12) KMK DUNKA INC. (1/12) DRM MINERALS CORP. (1/12)	0.677
610-0011-03810 and 610-0011-03811	26	61	12	UND 3/4 (CE) AND UND 1/4 (CE) OF SE1/4 OF SE1/4	CLIFFS ERIE LLC	PETER WOODBURY (3/4)	DUNKA MINERALS CORP. (1/12) KMK DUNKA INC. (1/12) DRM MINERALS CORP. (1/12)	0.048
610-0011-03860	27	61	12	SE1/4 OF SE1/4	USA	STATE OF MINNESOTA		0.333
610-0011-04400	33	61	12	SE1/4 OF SE 1/4	MESABI IRON CO	MESABI IRON CO		2.152
610-0011-04440	34	61	12	That part of the NE1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		22.694

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-04441	34	61	12	That part of the NE¼ of NE¼, Section 34, Township 61 North, Range 12 West, EXCEPT that part lying W'ly and NW'ly of a line drawn parallel with and distant 200 ft. W'ly and NW'ly of the first following described line and W'ly, NW'ly and N'ly of the second following described line: First Described Line: Commencing at the E quarter corner of Section 9, Township 60 North, Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the E line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St Louis County Transverse Mercator 1996 projection, a distance of 462.67 ft. to the point of beginning of the line to be described; thence NE'ly along a non-tangential curve concave to the E, having a radius of 2925.20 ft., central angle of 46 degrees 35 minutes 13 seconds, the tangent to said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 ft. to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 ft., central angle of 13 degrees 13 minutes 05 seconds, a distance 280.81 ft. to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 ft.; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 ft., central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 ft. to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 ft., central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 ft. to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 ft.; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 ft., central angle of 04 degrees 00 minutes 27 seconds , a distance of 63.66 ft. to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 ft. and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 ft. to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of482.88 ft.; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 ft.; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 ft.; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 ft.; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 ft.; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 ft.; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 ft., and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.465
610-0011-04450	34	61	12	NW1/4 OF NE1/4	USA	STATE OF MINNESOTA		0.125
610-0011-04450	34	61	12	NW1/4 OF SW1/4	USA	USA		1.248
610-0011-04450	34	61	12	SE1/4 OF NW1/4	USA	USA		0.606
610-0011-04450	34	61	12	SW1/4 OF SW1/4	USA	USA		34.392
610-0011-04460	34	61	12	That part of the SW1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	USA		24.741
610-0011-04470	34	61	12	That part of the SE¼ of NE¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	USA		1.156

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-04475	34	61	12	That part of the SE1/4 OF NE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	USA		18.534
610-0011-04520	34	61	12	That part of the NE¼ of SW¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.886
610-0011-04525	34	61	12	That part of the NE1/4 OF SW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		26.34

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-04550	34	61	12	That part of the SE¼ of SW¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		0.286
610-0011-04555	34	61	12	That part of the SE1/4 OF SW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		15.915
610-0011-04570	34	61	12	That part of the NW¼ of SE¼, Section 34 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		3.004

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-04575	34	61	12	That part of the NW1/4 OF SE1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		13.173
610-0011-04645	35	61	12	Northeast Quarter of Northwest Quarter, Section 35, Township 61 North, Range 12 West, St. Louis County, Minnesota, lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast , having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds , a distance of 2463.58 feet to the point of tangency ; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet ; thence northeasterly along a tangential curve concave to the southeast , having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	State of Minnesota (Remainder. See notes)	Dunka Minerals Corporation (20/864) KMK Dunka Inc. (20/864) DRM Minerals Corporation (20/864) Harold A. Knutson, as trustee of the Harold A. Knutson Living Trust under Agreement dated April 30, 2008 (5/576) Darryl E. Coons (5/576) Duluth-Superior Area Community Foundation (5/576) Peter Woodbury (180/864) Nancy Jordan (1/10 of 10/864) Susan Eastep (1/10 of 10/864) Cynthia Williams (1/10 of 10/864) John Mahler (1/10 of 10/864) Elizabeth Gowdy (1/10 of 10/864) The Thomas J. Manthey Disclaimer Trust F/B/O Virginia P Manthey (1/2 of 864) John Jacob Spencer Jr. (10/4032) Frank Christopher Spencer (10/4032) Charlotte Spencer Miller (10/4032) Florence Spencer Schmidt (10/4032)	0.314
610-0011-04650	35	61	12	That part of the NW¼ of NW¼, Section 35 Township 61 North Range 12 West; lying E'ly and SE'ly of a line drawn parallel with and distant 200 feet W'ly and NW'ly of the first following described line and E'ly, SE'ly and S'ly of the second following described line: First Described Line: Commencing at the East quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the East line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection, a distance of 462.67 feet to the point of beginning of the line to be described ; thence NE'ly along a non-tangential curve concave to the East, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence NE'ly along a tangential curve concave to the NW, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence NE'ly along a tangential curve concave to the SE, having a radius of 910.15 feet , central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148 .61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	CLIFFS ERIE LLC	STATE OF MINNESOTA		5.956

Table 1: Surface and Mineral Ownership Information for the Twin Metals Minnesota Project Area

610-0011-04655	35	61	12	That part of the NW1/4 OF NW1/4 lying westerly and northwesterly of a line drawn parallel with and distant 200 feet westerly and northwesterly of the first following described line and westerly, northwesterly and northerly of the second following described line: First Described Line: Commencing at the east quarter corner of Section 9 Township 60 North Range 12 West; thence S 71 degrees 44 minutes 20 seconds W, bearing based on the east line of said Section 9 having a bearing of S 03 degrees 27 minutes 19 seconds E, St. Louis County Transverse Mercator 1996 projection , a distance of 462.67 feet to the point of beginning of the line to be described; thence northeasterly along a non-tangential curve concave to the east, having a radius of 2925.20 feet, central angle of 46 degrees 35 minutes 13 seconds, the tangent of said curve at this point bears N 22 degrees 35 minutes 37 seconds W a distance of 2378.47 feet to the point of tangency; thence N 23 degrees 59 minutes 36 seconds E a distance of 426.28 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 1217.20 feet, central angle of 13 degrees 13 minutes 05 seconds, a distance of 280.81 feet to the point of tangency; thence N 37 degrees 12 minutes 41 seconds E, a distance of 1001.36 feet; thence northeasterly along a tangential curve concave to the northwest, having a radius of 3780.62 feet, central angle of 32 degrees 51 minutes 39 seconds, a distance of 2168.30 feet to the point of tangency; thence N 04 degrees 21 minutes 02 seconds E, a distance of 2244.11 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 2866.16 feet, central angle of 49 degrees 14 minutes 53 seconds, a distance of 2463.58 feet to the point of tangency; thence N 53 degrees 35 minutes 54 seconds E, a distance of 664.36 feet; thence northeasterly along a tangential curve concave to the southeast, having a radius of 910.15 feet, central angle of 04 degrees 00 minutes 27 seconds, a distance of 63.66 feet to the point of tangency; thence N 57 degrees 36 minutes 21 seconds E a distance of 1469.17 feet, and there terminating. Second Described Line: Commencing at the point of termination of the first above-described line; thence N 32 degrees 23 minutes 39 seconds W a distance of 200 feet to the point of beginning of the line to be described; thence N 06 degrees 23 minutes 50 seconds W a distance of 482.88 feet; thence N 34 degrees 17 minutes 24 seconds E a distance of 1692.54 feet; thence S 77 degrees 26 minutes 00 seconds E a distance of 1541.34 feet; thence N 52 degrees 08 minutes 41 seconds E a distance of 1454.79 feet; thence N 68 degrees 02 minutes 16 seconds E a distance of 148.61 feet; thence N 51 degrees 03 minutes 13 seconds E a distance of 321 feet; thence N 41 degrees 52 minutes 37 seconds E a distance of 459.18 feet, and there terminating.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		13.584
610-0011-04760	36	61	12	SE1/4 OF SE1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		1.985
610-0011-04760	36	61	12	SW1/4 OF SE1/4	STATE OF MINNESOTA	STATE OF MINNESOTA		7.441
610-0011-04800	36	61	12	NE1/4 OF NW1/4 TO THE WEST OF THE NORMAL HIGH WATER MARK OF BIRCH LAKE	RENDFIELD LAND CO INC	STATE OF MINNESOTA		0.772
610-0011-04810	36	61	12	NW1/4 of Section 36 Township 61 North Range 12 West of the Fourth Principal Meridian EXCEPT SE1/4 of NW1/4, Section 36, Township 61 North, Range 12 West. AND FURTHER EXCEPT Those parts of NW1/4 of NW1/4, Section 36, Township 61 North, Range 12 West, lying W'ly of "Line A" to be described and 300.00 feet NW'ly of and 300.00 SE'ly of, measured at right angles to and parallel with "Line B" to be described. "Line A" and "Line B" are described as follows; "Line A" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said NW1/4 of NW1/4, a distance of 334.90 feet; thence E'ly a distance of 22.42 feet along a non-tangential curve concave to the N, having a radius of 333.00 feet, a central angle of 03 degrees 51 minutes 28 seconds, and a chord bearing S 89 degrees 30 minutes 36 seconds E; thence E'ly a distance of 257.22 feet along a reverse curve concave to the S, having a radius of 484.00 feet, and a central angle of 30 degrees 26 minutes 59 seconds to the beginning of the line to be described; thence continuing E'ly a distance of 491.25 feet along the same curve having a radius of 484.00 feet, a central angle of 58 degrees 09 minutes 15 seconds; thence S 03 degrees 48 minutes 53 seconds E, a distance of 919.86 feet to the S line of said NW1/4 of NW1/4 and said "Line A" there terminating. "Line B" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1325.94 feet and said "Line B" there terminating. The side lines of said 300.00 foot wide strips terminate on the N and W lines of said NW1/4 of NW1/4. AND FURTHER EXCEPTING That part of SW1/4 of NW1/4 Section 36, Township 61 North, Range 12 West, lying 300.00 SE'ly of, measured at right angles to and parallel with a line described as follows: Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1895.30 and said line there terminating. The said line of said 300.00 foot wide strip terminates on the N and W lines of said SW1/4 of NW1/4.	RENDFIELD LAND CO INC	STATE OF MINNESOTA		19.391
610-0011-04811	36	61	12	Those parts of NW1/4 of NW1/4, Section 36, Township 61 North, Range 12 West, lying W'ly of "Line A" to be described and 300.00 feet NW'ly of and 300.00 SE'ly of, measured at right angles to and parallel with "Line B" to be described. "Line A" and "Line B" are described as follows; "Line A" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said NW1/4 of NW1/4, a distance of 334.90 feet; thence E'ly a distance of 22.42 feet along a non-tangential curve concave to the N, having a radius of 333.00 feet, a central angle of 03 degrees 51 minutes 28 seconds, and a chord bearing S 89 degrees 30 minutes 36 seconds E; thence E'ly a distance of 257.22 feet along a reverse curve concave to the S, having a radius of 484.00 feet, and a central angle of 30 degrees 26 minutes 59 seconds to the beginning of the line to be described; thence continuing E'ly a distance of 491.25 feet along the same curve having a radius of 484.00 feet, a central angle of 58 degrees 09 minutes 15 seconds; thence S 03 degrees 48 minutes 53 seconds E, a distance of 919.86 feet to the S line of said NW1/4 of NW1/4 and said "Line A" there terminating. "Line B" Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1325.94 feet and said "Line B" there terminating. The side lines of said 300.00 foot wide strips terminate on the N and W lines of said NW1/4 of NW1/4.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		10.944
610-0011-04821	36	61	12	That part of SW1/4 of NW1/4 Section 36, Township 61 North, Range 12 West, lying 300.00 SE'ly of, measured at right angles to and parallel with a line described as follows: Commencing at the NW corner of said Section 36; thence S 88 degrees 33 minutes 39 seconds E along the N line of said Section 36, a distance of 334.90 feet to the beginning of the line to be described; thence S 14 degrees 59 minutes 50 seconds W, a distance of 1895.30 and said line there terminating. The said line of said 300.00 foot wide strip terminates on the N and W lines of said SW1/4 of NW1/4.	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		31.131
610-0011-04840	36	61	12	NE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		15.511
610-0011-04850	36	61	12	NW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		28.883
610-0011-04860	36	61	12	SW 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		0.787
610-0011-04870	36	61	12	SE 1/4 OF SW 1/4	FRANCONIA MINERALS (US) LLC	STATE OF MINNESOTA		31.431

APPENDIX B

RECLAMATION PLAN

PROJECT RECLAMATION PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
Prepared by Barr Engineering Co.

Document No. TMM-EG-115-0004
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	n/a	1.0

REVISION NARRATIVE

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION / BACKGROUND 7
1.1 PROJECT OVERVIEW 7
1.2 RECLAMATION PLAN PURPOSE AND OBJECTIVES 7
1.3 PROJECT LOCATION AND DESCRIPTION 8
1.4 PROJECT ENVIRONMENTAL SETTING 9
1.5 PROJECT DEVELOPMENT STAGES 9
2.0 RECLAMATION PLAN DESIGN BASIS 10
2.1 REGULATORY FRAMEWORK 11
2.2 POST-CLOSURE LAND USE 11
2.3 GEOCHEMISTRY 12
2.4 DEVELOPMENT ROCK, WASTE ROCK, AND ORE 12
2.5 UNDERGROUND MINE BACKFILL 12
3.0 CLOSURE 12
3.1 UNDERGROUND MINE AREA AND ASSOCIATED FACILITIES 13
3.1.1 Underground Equipment and Infrastructure 13
3.1.2 Mine Declines and Underground Mine 14
3.1.3 Ventilation Shafts and Surface Ventilation Structures 14
3.2 PLANT SITE AND ASSOCIATED FACILITIES 15
3.2.1 Portals to the Underground Mine 17
3.2.2 Buildings 18
3.2.3 Electrical / Power 18
3.2.4 Supporting Equipment and Infrastructure 18
3.2.5 Fuel Storage Area 19
3.2.6 Pipelines 19
3.2.7 Laydown and Storage Areas 19
3.2.8 Ponds 19
3.2.9 Service Roads and Parking 20
3.2.10 Stockpiles 20
3.2.11 Sanitary Management Systems 20

3.2.12 Surface Water Management 21
3.3 CORRIDORS 21
3.3.1 Access Road Corridor 22
3.3.2 Water Intake Corridor 23
3.3.3 Transmission Corridor 24
3.3.4 Corridor Surface Water Management 24
3.4 NON-CONTACT WATER DIVERSION AREA 24
3.5 TAILINGS MANAGEMENT SITE 25
3.5.1 Tailings Dewatering Plant 28
3.5.2 Pipelines 28
3.5.3 Lined Dry Stack Facility 29
3.5.4 Ponds 32
3.5.5 Electrical / Power 32
3.5.6 Tailings Management Site Service Roads 33
3.5.7 Reclamation Material Stockpile 33
3.5.8 Laydown and Storage Areas 33
3.5.9 Surface Water Management 33
3.6 OTHER SUPPORTING INFRASTRUCTURE 34
3.6.1 Drill Holes and Wells 34
3.6.2 Fencing 35
3.7 MATERIAL DISPOSAL 35
3.7.1 Product Disposal 35
3.7.2 Demolition Waste Disposal 35
3.7.3 Solid Waste and Industrial Solid Waste Disposal 35
3.7.4 Special Material Disposal 35
4.0 WATER QUALITY 36
4.1 EROSION CONTROL BMPS 36
4.2 GROUNDWATER QUALITY 36
4.3 SURFACE RUNOFF CONTROL 37
4.4 WATER TREATMENT 37

5.0 REVEGETATION 38
5.1 REFERENCE SITES AND REVEGETATION TEST PLOTS 38
5.2 SOIL PREPARATION / MANAGEMENT 38
5.3 PLANTINGS 39
5.4 REVEGETATION SUCCESS CRITERIA 39
5.5 WILDLIFE 40
6.0 RECLAMATION EQUIPMENT AND RESOURCES 41
7.0 VARIANCE FROM RULES 41
8.0 CLOSURE TIMELINE 41
8.1 PLANNED CLOSURE 41
8.2 TEMPORARY CLOSURE 42
8.3 CONTINGENCY CLOSURE 43
9.0 CLOSURE DOCUMENTATION AND REPORTING 44
10.0 POST-CLOSURE MAINTENANCE, MONITORING, AND REPORTING 44
10.1 MAINTENANCE AND MONITORING 44
10.2 REPORTING 46
11.0 FUTURE LAND USE RESTRICTIONS 47

FIGURES

Figure 1-1 Project Overview and Location
Figure 1-2 Overview Map – Project Area East of Birch Lake Reservoir
Figure 1-3 End of Operations – Plant Site
Figure 1-4 End of Operations – Non-Contact Water Diversion Area
Figure 1-5 End of Operations –Tailings Management Site
Figure 3-1 Existing Conditions – Ventilation Raise Sites
Figure 3-2 End of Operations – Ventilation Raise Sites
Figure 3-3 Closure – Ventilation Raise Sites
Figure 3-4 Existing Conditions – Plant Site
Figure 3-5 End of Operations – Plant Site
Figure 3-6 Closure – Plant Site
Figure 3-7 Post-Closure – Plant Site
Figure 3-8 Existing Conditions – Access Road and Water Intake Corridors
Figure 3-9 End of Operations – Access Road and Water Intake Corridors
Figure 3-10 Closure – Access Road and Water Intake Corridors
Figure 3-11 Existing Conditions – Transmission Corridor
Figure 3-12 End of Operations – Transmission Corridor

Figure 3-13 Closure – Transmission Corridor
Figure 3-14 Existing Conditions – Non-Contact Water Diversion Area
Figure 3-15 End of Operations – Non-Contact Water Diversion Area
Figure 3-16 Closure – Non-Contact Water Diversion Area
Figure 3-17 Existing Conditions – Tailings Management Site
Figure 3-18 Incremental Development and Concurrent Reclamation – Dry Stack Facility
Figure 3-19 End of Operations – Tailings Management Site
Figure 3-20 Closure – Tailings Management Site
Figure 3-21 Post-Closure – Tailings Management Site
Figure 3-22 Tailings Management Site Water Management Site Conceptual Model
Figure 5-1 Existing Land Cover – Project Area East of Birch Lake Reservoir

TABLES

Table 1-1 Project Development Stages and Associated Project Activities 10
Table 2-1 Proposed Post-Closure Land Use 11
Table 3-2 Plant Site Surface Features for Closure 16
Table 3-3 Corridor Features for Closure 22
Table 3-4 Non-Contact Water Diversion Area Features for Closure 25
Table 3-5 Tailings Management Site Features for Closure 27
Table 10-1 Post-Closure Maintenance and Inspection 45
Table 10-2 Post-Closure Reporting 47

ATTACHMENTS

Attachment B.1 TMM Project Reclamation Plan Summary
Attachment B.2 Reclamation Plans – Synopsis of Rules

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

%	percent
Barr	Barr Engineering Co.
BLM	Bureau of Land Management
BMPs	best management practices
Declines	mine declines
e.g.	Latin phrase exempli gratia meaning “for example”
etc.	abbreviation for the Latin phrase et cetera meaning "and other similar things" or "and so forth"
FSM	Forest Service Manual
ft	feet
i.e.	Latin phrase *id est* meaning “That is (to say)…”
km	kilometer
LLR	longitudinal longhole retreat
m	meter
MDH	Minnesota Department of Health
MDNR	Minnesota Department of Natural Resources
Minn. R.	Minnesota Administrative Rules
MPCA	Minnesota Pollution Control Agency
MPO	Mine Plan of Operations
NPDES	National Pollutant Discharge Elimination System
Plan	Reclamation Plan
Project	Twin Metals Minnesota Project
PTM	Permit to Mine
RCRA	Resource Conservation and Recovery Act
SNF	Superior National Forest
SPCC	spill prevention, control, and countermeasure
SWMS	surface water management system
TDP	tailings dewatering plant
TMM	Twin Metals Minnesota LLC
USFS	U.S. Forest Service
USNRC	U.S. Nuclear Regulatory Commission

1.0 INTRODUCTION / BACKGROUND

1.1 Project Overview

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of Ely, Minnesota, and 11 miles (18 km) northeast of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

The Project encompasses the following primary areas: the underground mine area, the plant site, the tailings management site for filtered tailings preparation and storage, the non-contact water diversion area, the access road corridor, the water intake corridor, and the transmission corridor.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

1.2 Reclamation Plan Purpose and Objectives

This document is the Reclamation Plan to be submitted by TMM for the purpose of providing necessary information for the environmental review and future permitting processes. TMM retained Barr Engineering Co. (Barr) to complete this Reclamation Plan (Plan). The Plan for the Project is submitted by TMM to the U.S. Department of the Interior, Bureau of Land Management (BLM) Northeastern State Office and the Minnesota Department of Natural Resources (MDNR) in compliance with requirements set forth in Title 43, Code of Federal Regulations Sections 3592.1 (and applicable sub-sections referenced therein) and Minnesota Rules (Minn. R.), chapter 6132, respectively. TMM is submitting, under separate cover, a Mine Plan of Operations (MPO) for the Project.

A summary of the Project components that would be reclaimed, the general reclamation approach for each component, and an estimated schedule for the closure and post-closure maintenance and monitoring project development stages is provided in Attachment B.1.

Reclamation is the process of restoring properties mined or modified to support mining, to a natural condition or economically usable purpose, including controlling and protecting against potential adverse environmental effects and planning for and facilitating future orderly development of the properties. Reclamation includes the measures undertaken to bring about the necessary reconditioning or restoration of

lands or water affected by exploration, mining, on-site processing operations or waste disposal in a manner which, among other things, will prevent or control on- or off-site damage to the environment. Reclamation can occur during all stages of the Project including construction, operations, closure, and post-closure maintenance and monitoring. In this Plan, when reclamation occurs during the construction or operations stage it is referred to as concurrent reclamation. Project development stages are described in Section 1.5.

Under 43 CFR, Subpart 3592[1], before conducting operations on lease lands, the BLM requires the lessee to submit an MPO providing for, among other things, "the protection of non-mineral resources and for the reclamation of the surface of the lands affected by the operations." The BLM's regulations also require the MPO to include "a reclamation schedule and the measures to be taken for surface reclamation."

This Plan, in addition to providing reclamation information for supporting Project environmental review and future state and federal permitting processes, has been prepared to fulfill the requirements of the MPO. The Plan was prepared to a level of detail commensurate with current Project definition. Additional detail would be added to the Plan to support future permitting (e.g., Permit to Mine (PTM) application) and address regulatory agency input. Following permitting, this Plan would be updated annually to remain current with in-field conditions and TMM reclamation obligations.

Ultimately, TMM would be required under Minn. R., part 6132.1100 to provide the MDNR with mining and reclamation maps showing both the anticipated mining operation and the planned closure and post-closure activities for facilities used in the mining operations, including storage piles, tailings management facilities, mine, reservoirs, dams, diversion channels, and drainage control structures.

TMM would also need to comply with all applicable reclamation requirements set forth in federal or state surface authorizations, mineral leases, permits, and applicable land management plans. TMM expects that specific reclamation requirements will be developed during the environmental review and permitting process.

1.3 Project Location and Description

The vicinity of the Project relative to regional features and the general configuration of the Project is shown on Figure 1-1. The Maturi deposit lies between the

[1] U.S. Code of Federal Regulations, Title 43 Public Lands: Interior. Part 3590. Subpart 3592 Plans and Maps. Section 3592.1 Operating Plans

northernmost end of the Iron Range and the southwestern border of the Boundary Waters Canoe Area Wilderness within the SNF.

The primary Project features are shown on Figure 1-2 through Figure 1-5 and include:

- Underground mine area including mine declines (declines) and ventilation raise sites 1, 2, and 3;
- Plant site;
- Tailings management site, including the tailings dewatering plant and lined dry stack facility (which would be a permanent feature) for tailings management;
- non-contact water diversion area (inclusive of permanent water diversion features consisting of dikes and ditches);
- Access road corridor;
- Water intake corridor; and
- Transmission corridor

A comprehensive description of the Project is provided in the MPO.

1.4 Project Environmental Setting

The Project environmental setting is described in the MPO.

1.5 Project Development Stages

Table 1-1 summarizes development stages for the Project. As noted in Section 1.2, reclamation can occur during all stages of the Project. When reclamation occurs during the construction or operations stage, it is referred to as concurrent reclamation.

Table 1-1 Project Development Stages and Associated Project Activities

Project Development Stages	Associated Project Activities
Construction	In this Plan, the “construction” stage includes Project activities occurring prior to extraction of ore such as, but not limited to, construction of processing facilities, mine declines, utilities, TDP, the first phase of the lined dry stack facility, and water management features.
Operations	In this Plan, the “operations” stage includes Project activities performed to extract and process ore, and ancillary activities such as, but not limited to, water and waste management. Reclamation that occurs during this Project development stage is referred to as “concurrent reclamation” in this Plan.
Closure	In this Plan, the "closure" stage includes Project activities to rehabilitate the mine site after operations have ceased, to create the intended post-mining landscape. Closure stage activities include, but are not limited to, decommissioning, removal, and / or abandonment of infrastructure, land forming, and revegetation. Reclamation activities that occur during the Closure stage are referred to as “reclamation” in this Plan. *Note, closure is also an activity (in addition to being a Project development stage). Closure, the activity, means the process of terminating and completing final steps in reclaiming any specific portion of a mining operation (e.g., closure of a pond may include removing and disposing of residual sediments and liner materials, filling and regrading the surface depression, and revegetating the pond footprint to meet future land use plans).*
Post-Closure Maintenance and Monitoring	In this Plan, the “post-closure maintenance and monitoring” stage includes Project monitoring activities performed to confirm post-mining requirements (including post-closure performance criteria) have been achieved. It also includes maintenance activities that may be required to sustain reclaimed areas after cessation of mining.

2.0 RECLAMATION PLAN DESIGN BASIS

The Plan design basis considers regulatory requirements, planned post-closure land use, material characterization, and health and safety hazards. The combination of these aspects provides the key considerations used in the development of the Plan. The Plan design basis relies on information available at the time of Plan issuance. The design basis would be periodically updated as Project definition increases during future phases of Project design and development.

2.1 Regulatory Framework

A synopsis of the regulatory framework for reclamation plans is provided in Attachment B.2.

Further, “storm water or stormwater” is defined in Minn. R., chapter 7090, part 7090.0080, as storm water runoff, snow melt runoff, and surface runoff and drainage. Instead of using only the regulatory term “stormwater” throughout this Plan, reference is made to specific sub-parts of stormwater and methods of management, as needed for clarity.

Plan content would change over time as the Project progresses through environmental review and permitting, final design, and the construction, operations, closure, and post-closure maintenance and monitoring project development stages. Further, none of the infrastructure depicted in this Plan has been constructed.

2.2 Post-Closure Land Use

While there are many post-closure land use options for the Project, this Plan is based on the post-closure land uses listed in Table 2-1.

Table 2-1 Proposed Post-Closure Land Use

Project Area / Feature	Proposed Post-Closure Land Use
Underground Mine *(including declines)*	No planned post-closure use; to be reclaimed per approvals required under Title 43 CFR Subpart 3595.2 – Abandonment of Underground Workings
Plant Site, Access Road Corridor, Water Intake Corridor, Transmission Corridor, and Ventilation Raise Sites	Natural area, with publically accessible portions returned to existing uses such as recreation - would include range of mixed hardwood pine forest to jack pine barrens
Non-Contact Water Diversion Area	Natural area, with publically accessible portions returned to existing uses such as recreation – would include permanent drainage features (dikes and ditches) and be reclaimed as a range of mixed hardwood pine forest to jack pine barrens
Tailings Management Site	Natural area, with publically accessible portions returned to existing uses such as recreation – would include permanent lined dry stack facility features and be reclaimed as a range of diverse grasslands with pollinator species

2.3 Geochemistry

Geochemical information for development rock, waste rock, ore, and tailings continues to be developed. Future testing would be performed per work plans developed with input from the MDNR and BLM. Refer to the MPO for additional geochemistry information.

2.4 Development Rock, Waste Rock, and Ore

Refer to the MPO for a description of development rock, waste rock, and ore.

Development rock used in above grade construction would be integrated into the reclaimed surface at the closure stage of the Project. As part of closure stage activities, development rock could also be relocated from the surface to the upper segment of the declines and at the portal to serve as mass structural barrier. Ore would be processed prior to the closure stage of the Project. As a result, no ore stockpiles would remain on the surface after the operations stage of the Project.

2.5 Underground Mine Backfill

During mining, the underground mine would be progressively backfilled with an engineered tailings backfill produced at the surface and distributed via the declines through the underground mine using a system of pipes secured within the stopes and drifts. The engineered tailings backfill would contain thickened tailings and binder. In some stopes, waste rock would be backfilled into empty stopes prior to the stopes being filled with the engineered tailings backfill. In reclaimed portions of the underground mine, in-mine groundwater levels would naturally reestablish over time.

3.0 CLOSURE

Closure and reclamation procedures described herein are based on the best available information at the time of Plan preparation, including industry standard practices, site-specific conditions, and preliminary engineering and design evaluations. This Plan would be periodically updated as Project definition increases leading up to the construction project stage. Additionally, some aspects of the environmental and operational conditions would need to be investigated further during the operations stage of the Project to inform closure and reclamation planning. This information would be incorporated into the Plan through periodic updates in accordance with regulatory requirements.

Public safety would be maintained throughout the closure stage of the Project and equipment and facilities would be maintained in a safe and orderly manner. To protect public safety, activities would be conducted in conformance with applicable federal and state health and safety requirements. In critical areas not already fenced, temporary perimeter fencing would be installed to restrict public access during the

closure stage and appropriate signage would be displayed. Access roads with restricted access during the operations stage of the Project would retain restricted access during the closure stage. Critical areas include, but are not limited to, mine portals and ventilation raise sites. The plan for infrastructure closure and reclamation is summarized in the following sections.

3.1 Underground Mine Area and Associated Facilities

The ore deposit would be accessed by two declines extending from the plant site (an access decline and a conveyor decline). The underground mine operation would use the Longitudinal Longhole Retreat (LLR) mining method (a type of sublevel stoping where ore is progressively blasted from a higher level and falls to a draw point for removal). LLR would utilize both primary and secondary stopes. Engineered tailings backfill and waste rock would be used to backfill mined out stopes throughout the life of mine. The intake raises and exhaust raises would be constructed for mine ventilation. Fans would be installed at the top of the intake raises and at the bottom of the exhaust raises.

The location of the surface facilities (i.e., ventilation raise sites) associated with the underground mine requiring closure are shown on Figure 3-1 through Figure 3-3, which generally show:

- Pre-mine site conditions (as reference for potential closed condition objective);
- End of operations site conditions; and
- Surface infrastructure removal for closure.

3.1.1 Underground Equipment and Infrastructure

For underground mine area equipment and infrastructure, closure would include removal of mobile items and items having potential alternate off-site uses or salvage value, and removal of equipment and infrastructure having potential to impact future groundwater quality.

Underground equipment and infrastructure whose useful life has been consumed, having limited or no off-site reuse or salvage value, that would not easily be removed and recovered from underground, and / or that has no notable potential to impact future groundwater quality (i.e., cable casing of polyethylene or similar, insufficient quantity to cause impact, etc.) would remain in place below ground (in accordance with federal and / or state approvals as necessary).

Prior to closing the underground mine, self-propelled mobile equipment (inclusive of associated coolant, oil, and gas) would be removed from the underground mine, and mobile but not self-propelled (and not fixed in place) equipment having economic re-use or salvage value off site would be removed from the underground mine.

If spills were to occur in the underground mine area and supporting facilities, or anywhere on the Project, they would be addressed in accordance with Project spill prevention, control, and countermeasure (SPCC) plans, which would be developed prior to the construction stage of the Project.

Fixed equipment is bolted, structurally mounted, epoxied, drilled into, or fastened by some other means to the floor, walls, or roof of the underground mine. Examples of underground fixed equipment include low and high voltage power distribution cables, communication cables, cable trays, lighting, magazines for explosives storage, ventilation ducts, roof supports, mine backfill distribution piping, and water removal piping systems. Because none of this equipment and infrastructure would be likely to have economic value for reuse or salvage, such infrastructure would be difficult to remove, and such infrastructure would be unlikely to affect future groundwater quality (i.e., cable casing of polyethylene or similar, insufficient quantity to cause impact, etc.), it would remain in place at closure.

3.1.2 Mine Declines and Underground Mine

Much of the underground mine would be progressively backfilled during the operations Project stage, as a means of providing ground support for underground mining activities, and as a means of permanently storing tailings generated during mining. Approximately 40% of tailings are anticipated to be returned underground in the form of engineered tailings backfill during the operations stage.

While much of the underground mine would be backfilled through the course of mining, there would be portions of the underground mine remaining unfilled. After mine operations cease these portions of the mine would be allowed to passively fill with groundwater as groundwater levels progressively rise to pre-mining conditions. Because of the plan to fill the stopes with engineered tailings backfill within the ore zone, to allow the mine to fill with groundwater, and to seal the mine portal and ventilation shafts upon closure, the potential for oxidation of sulfide minerals along the wall rock, in the underground mine, would be limited. As a result, mobilization of metals from exposed mine walls and ore remaining underground would be expected to be minimal.

The ground surface above the declines and above the underground mining area are not expected to be subject to measurable ground subsidence, so on-surface reclamation to address subsidence is not expected.

3.1.3 Ventilation Shafts and Surface Ventilation Structures

For the surface ventilation structures and for all Project structures, prior to demolition, equipment would be inventoried and generally categorized as saleable, salvageable (for reuse), recyclable, or for disposal. Equipment would be recovered from the structures and managed according to these classifications preceding the initiation of demolition.

Surface ventilation structures would be demolished unless a post-mining land use is identified and concurred with by the appropriate regulatory and land management agencies. Some of the building materials may be salvageable or recyclable and would be removed from the site. Pipelines associated with the buildings would be removed. Those materials which are unsalvageable and unrecyclable, and meet the solid waste disposal criteria, would be disposed of in a licensed landfill.

Project-wide, above-grade building foundation walls and equipment foundations buried 0 to 2 ft (0 to 0.6 m) below grade, would be broken and buried in place or in some instances may be removed and placed in the declines. Below grade, non-ventilation shaft spaces would be filled with clean material. Non-hazardous demolition debris would be removed and disposed of as deemed appropriate and in accordance with regulatory requirements. If present, hazardous debris would be removed and transported to a licensed facility for disposal. Prefabricated buildings would be dismantled and hauled to a licensed landfill for disposal or removed from the site for alternate use.

Ventilation shafts, which would vary between 17 and 20 ft (5.2m and 6.1m) in diameter, would be sealed in accordance with requirements of Minnesota state law and local requirements. The sites would be covered with growth media and revegetated to establish a land use similar to adjacent undisturbed lands. Revegetation procedures are described in Section 5.0.

3.2 Plant Site and Associated Facilities

Typical existing, end of operations, closure, and post-closure site conditions for the plant are shown on Figure 3-4 through Figure 3-7, respectively. The plant site includes a variety of structures and supporting infrastructure, generally categorized as follows:

- Portals to the underground mine
- Buildings
- Electrical / power
- Supporting equipment / infrastructure
- Fuel storage
- Laydown / pad / storage
- Ponds
- Service roads (to aide figure clarity, minor service roads are not shown) and parking areas
- Pipelines
- Stockpiles

Removal of structures and supporting infrastructure would generally include sale, salvage or recycling (when practicable / feasible), demolition, or disposal, followed by landscape restoration. Application of this sequence to the plant site surface

infrastructure is summarized in the following sections. Surface water management at the plant site for the closure and post-closure stages is described in Section 3.2.12. Erosion control best management practices (BMPs), and general surface water controls to protect water quality to be applied throughout closure and reclamation, are presented in Section 4.0. The general methods for restoration, typically consisting of landscape restoration and revegetation, are described in Section 5.0.

Table 3-1 provides an inventory of plant site surface features requiring closure and reclamation, and the planned reclamation approach.

Table 3-1 Plant Site Surface Features for Closure

Feature Type	Name	Reclamation Approach
Portals to the Underground Mine	Portals	Permanently sealed to prevent access
Buildings	Concentrator	Remove and sell, salvage, recycle, or dispose – regrade and revegetate footprint
	Concentrator Services Building	
	Service Building (for Ponds)	
	Reagent Storage	
	Security	
	Mine Services Building	
Electrical / Power	General Power Distribution Lines within Plant Site Footprint	Remove and sell, salvage, recycle, or dispose – regrade and revegetate footprint
	Plant Site Substation and the Primary Overhead Power-line from the Off-Site Substation	Leave in place – future use to be determined by utility provider
Supporting Equipment / Infrastructure	Explosives Magazine	Remove and sell, salvage, recycle, or dispose – regrade and revegetate footprint
	Propane Storage Tanks	
	Grinding Ball Storage	
	Conveyors	
	Tanks (mine water, process water, and fresh / fire water)	
	Shotcrete Plant	
	Transfer Station / Feed Hopper	
Fuel Storage	Diesel Fuel	Remove – regrade and revegetate footprint
Pipelines	Tailings	Remove and sell, salvage, recycle, or dispose
	Engineered Tailings Backfill	
	Process Water	

Feature Type	Name	Reclamation Approach
Laydown and Storage Areas	Laydown Areas	Regrade and revegetate
	Snow Storage Areas	
	Waste Storage Area	
	General Storage	
Ponds	North Contact Water Pond	Remove – regrade and / or fill as appropriate and revegetate (which could include converting to surface runoff drainage features or wetlands)
	Central Contact Water Pond	
	South Contact Water Pond	
	Process Water Pond	
	Sedimentation Water Pond	
Service Roads and Parking	Bus Loop	Remove or dispose – regrade and revegetate
	Parking Areas	
	Service Roadways	Retain and maintain portions needed to support future land use – otherwise, remove and regrade once no longer needed for closure and post-closure maintenance stage activities
Stockpiles (including liners if present)	Aggregate Stockpile (adjacent to the shotcrete plant)	Remove and recycle or dispose – regrade and revegetate
	Coarse Ore Stockpile	
	Overflow Ore Stockpile	
	Reclamation Material Stockpile 1 and 2	

3.2.1 Portals to the Underground Mine

The portal would remain open for delivery of power and other utilities as needed, through the course of closure until underground equipment and infrastructure planned for removal from the underground mine has been removed, and the planned underground mine backfilling has been completed. Access to the underground mine would be closed off to the public throughout the operations, closure, and post-closure maintenance and monitoring stages.

Once the underground mine closure activities had been completed as subsequently described, development rock (or other appropriate fill material) would be placed within the upper segment of the declines and at the portal to serve as a mass structural barrier to mine reentry. The exterior face of the barrier would be covered with a granular soil layer, above which rooting soil would be placed to support revegetation of the portal area. The mass structural barrier and soil cover would

serve to prevent future, conceivable means of unauthorized reentry to the declines and underground mine by way of the portal.

3.2.2 Buildings

The plant site includes a concentrator and a number of support buildings as listed in Table 3-1 and shown on Figure 3-5.

The concentrator and other buildings would be closed and the building sites reclaimed in the same manner as previously described for surface ventilation structures.

Materials regulated under RCRA would be stored within buildings, and would be containerized for bulk transport and shipped to storage facilities that comply with RCRA regulations. Solid wastes would be transported to licensed solid waste disposal facilities.

Buildings associated with the Project would be demolished unless a post-mining on-site use is identified and concurred with by the appropriate regulatory and land management agencies.

3.2.3 Electrical / Power

The closure approach for the overhead electric transmission lines at the plant site and for the plant site substation would be determined by TMM based on input from the utility provider. If a post-Project need is confirmed by TMM or the utility provider, these transmission lines and the substation would remain in place at closure. If a post-Project need is not confirmed, plant site power lines, distribution facilities, and the substation would be dismantled and the sites reclaimed in the manner previously described for surface ventilation structures.

Section 3.3.3 discusses the transmission line providing power to the plant site. Section 3.5.5 discusses power from the plant site to the tailings management site.

3.2.4 Supporting Equipment and Infrastructure

Supporting equipment / infrastructure includes but is not limited to:

- Explosives Magazine
- Propane Storage Tank
- Grinding Ball Storage
- Conveyors
- Tanks (mine water, process water, and fresh / fire water)
- Shotcrete Plant
- Transfer Station / Feed Hopper

Explosives remaining in the explosives magazine and propane remaining in storage would be retrieved by the corresponding supply vendors and transported off site for re-sale. Cement remaining in storage at the shotcrete plant would be consumed in mine site backfill or during closure of the mine site ventilation shafts.

3.2.5 Fuel Storage Area

Fuel storage areas include propane storage and diesel fuel storage. Remaining fuel would be consumed on site during the Closure stage, or hauled off site for uses allowed. On-site fuel storage areas would be dismantled. Saleable equipment and salvageable or recyclable materials would be removed and transported off site. Other debris would be hauled to a licensed landfill for disposal.

If spills were to occur they would be addressed in accordance with Project SPCC plans, which would be developed prior to the construction stage of the Project.

3.2.6 Pipelines

See Section 3.5.2 for discussion of pipeline extending between the plant site and tailings management site.

3.2.7 Laydown and Storage Areas

Saleable equipment and salvageable or recyclable materials in laydown areas would be removed and transported off site. Other debris would be hauled to a licensed landfill for disposal.

Additional cover soil would be imported as needed and the laydown areas would be regraded as necessary to restore, to the extent practicable, pre-mining surface runoff conditions. Snow storage areas would be regraded and re-vegetated as necessary to achieve desired post-closure surface runoff and re-vegetated surface conditions. Vegetation would be re-established per Section 5.0.

3.2.8 Ponds

Solids remaining in ponds would be removed and transported below grade at the mine site for mine backfill, or if sufficiently dewatered or dry, to the lined dry stack facility.

Saleable pumping or piping systems and salvageable or recyclable materials in pond areas would be removed and transported off site. Pond liners and other debris would be hauled to a licensed landfill for disposal.

Additional cover soil would be imported as needed and the pond areas would be regraded as necessary to restore, to the extent practicable, pre-mining surface runoff

conditions. Ponds could potentially be converted into surface runoff drainage features or wetlands. Vegetation would be re-established per Section 5.0.

3.2.9 Service Roads and Parking

Plant site service roads and associated infrastructure (i.e., parking areas and the bus loop) without a defined post-mining use would be reclaimed concurrent with mine operations if they are no longer needed for access. Plant site service roads needed to support future land use would be retained. Plant site service roads (including small vehicle roads) would be reclaimed once no longer needed for closure and post-closure maintenance stage activities. The primary reclamation objective for the roads would be to provide long-term stabilization and surface water management consistent with the intended post-closure land use.

3.2.10 Stockpiles

Stockpile areas would include:

- Coarse ore stockpile
- Overflow ore stockpile
- Reclamation material stockpiles

During the operations stage of the project, ore stockpile areas would be closed by processing the stockpiled ore to the extent possible. No ore would remain on the surface during the closure stage. Soil / rock materials located above stockpile liners, and used for construction of the hydraulic barrier component of stockpile liners, would be removed and transported along with remaining ore to the mine for backfill and / or closure of declines. Piping used in stockpile drainage systems would be removed and salvaged or disposed of at a licensed demolition debris landfill. Synthetic liners used for the hydraulic barriers in stockpile liner systems would be removed and disposed of at a licensed demolition debris landfill. Soils located below the hydraulic barrier component of stockpile liners would be regraded to match planned post-closure ground contours and would then be re-vegetated per Section 5.0

Reclamation material stockpiled during the construction stage of the Project would be spread across the plant site to create a growth medium for revegetation. The reclamation material stockpile locations would be regraded to match post-closure contours and would also be revegetated per Section 5.0.

3.2.11 Sanitary Management Systems

Sanitary management systems would be pumped out and the holding tanks would be removed and disposed of in a licensed landfill or filled with soil (or crushed rock) and then backfilled.

3.2.12 Surface Water Management

Closure and reclamation of the plant site would include use of surface water management features to control erosion and water runoff quality, quantity, and rates. Once the planned plant site post-closure surface topography is established, reclamation cover materials, serving as a growth medium for revegetation, would be placed. Additional details on placement of cover soils and establishing a growth medium for revegetation is provided in Section 5.2.

The post-closure surface of the plant site would be graded to re-establish pre-mining hydrology, which generally would allow the site to drain toward adjacent wetland complexes as shown on Figure 3-7, which would generally re-establish pre-mining flow directions and discharge locations. Reclamation design would aim to create conditions where runoff rates and volumes estimated for runoff reaching downstream surface water receptors are similar to pre-mining site conditions.

Post-closure grading plans and drainage features would be designed to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting site would be stabilized with erosion potential generally similar to pre-mining site conditions.

3.3 Corridors

The Project would include three main corridors including:

- Access road corridor
- Water intake corridor
- Transmission corridor

Typical existing, end of operations, and closure site conditions for the access road and water intake corridors are shown on Figure 3-8 to Figure 3-10, respectively. Typical existing, end of operations, and closure site conditions for the transmission corridor are shown on Figure 3-11 to Figure 3-13, respectively. Table 3-2 provides an inventory of corridor features requiring closure and reclamation and planned reclamation approach.

Table 3-2 Corridor Features for Closure

Feature Type	Name	Reclamation Approach
Access Road Corridor	Access Road	Maintain and potentially transfer ownership
Water Intake Corridor	Intake Pipeline(s) (from the Birch Lake reservoir to the water intake facility)	Remove and salvage, or dispose or abandon pipelines in place – per future agreements with MDNR
	Water Intake Facility (pump house)	Remove and sell, salvage, recycle, or dispose – regrade and revegetate
	Buried Communication Cables and Power Lines	Leave in place – terminate power supply
	Water Intake Pipeline (from intake facility to the plant site)	Remove and sell, salvage, recycle, or dispose
	Maintenance Access Road	Abandon in place – regrade and revegetate; removal of culverts to be determined on case-by-case basis
Transmission Corridor	Overhead Electric Transmission and Off-Site Electrical Substation	Leave in place – future use to be determined based on input from utility provider

3.3.1 Access Road Corridor

The access road would be left in place and maintained through the closure stage of the Project. Maintenance and / or reclamation of the access road after the closure stage would be determined based on future land use and access needs of surrounding properties. Transfer of ownership to a third party could also be considered if appropriate.

If the access road is not needed to meet future land use needs, it would be removed and reclaimed. Culverts crossing the access road would be removed and drainage channels would be formed and vegetated to facilitate proper drainage. Closure mitigations at access road crossings of wetlands would be per U.S. Army Corps of Engineers permit conditions. Unless otherwise required by permit, at wetland crossing locations, the access road would be abandoned in place. Culverts installed to maintain hydraulic connectivity between wetland locations intersected by the access road would be left in place or removed during the closure stage of the Project on a case-by-case, location-specific basis. If culverts are removed, drainage

channels would be constructed in place of the culverts and organic soil types would be placed. Portions of the access road remaining in place at the closure stage would be loosened and revegetated.

3.3.2 Water Intake Corridor

The water intake corridor would generally include the water intake facility (water intake building, intake pumps, intake pipes, parking area, and a vegetative screen); buried power and communication lines; buried water intake pipeline (from the intake facility to the plant site); and a maintenance road.

At the water intake facility, saleable equipment and salvageable or recyclable materials would be removed and transported off site. Remaining equipment and infrastructure would be removed and transported to a licensed landfill for disposal unless it is determined that abandoning infrastructure in place has a lower environmental impact (e.g., cap the intake pipeline and abandon in place to avoid temporary impacts to the Birch Lake reservoir associated with removal activities). The gravel parking area and access road would be ripped to loosen compacted surfaces and left in place. The vegetative screen would remain in place during the closure stage of the Project.

Buried power and communications lines would be decommissioned and abandoned in place. Once it is confirmed that the power supply to buried power lines has been disconnected, no further action would be performed.

The water intake pipeline between the water intake facility and the plant site would be removed and, if not saleable, salvageable, or recyclable, transported to a licensed landfill for disposal.

The maintenance access road would remain in place until infrastructure within the corridor has been fully reclaimed, after which maintenance access road restoration would be completed. Corridor surface restoration, including the maintenance access road, would consist of loosening compacted surfaces and regrading as needed to facilitate and manage surface runoff.

Additional cover soil would be imported as needed along the water intake corridor (including at the water intake facility). The water intake corridor would be regraded as necessary to restore, to the extent practicable, pre-mining surface water drainage patterns. Erosion control BMPs and general surface water controls to protect water quality, to be applied throughout the closure stage of the Project, are presented in Section 4.0. Once grading is complete, rooting soil would be imported as needed to establish vegetation per Section 5.0.

3.3.3 Transmission Corridor

Electric service would be delivered to the plant site from an off-site electrical substation using overhead electric transmission (power) lines. Overhead electric transmission lines providing power to the plant site would be disconnected from Project infrastructure and then be left in place at the closure stage of the Project. Future use of overhead electric transmission lines and the off-site electrical substation would be determined based on future input from the utility provider. Once it is confirmed power supply to the Project has been disconnected, no further action would be performed.

3.3.4 Corridor Surface Water Management

Reclamation design would aim to create conditions where runoff rates and volumes estimated to reach downstream surface water receptors are similar to pre-mining site conditions. Post-closure grading plans and drainage features would be designed to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting site would be stabilized with erosion potential generally similar to pre-mining site conditions. Additional details on placement of cover soils and establishing a growth medium for revegetation is provided in Section 5.2.

3.4 Non-contact Water Diversion Area

Typical existing, end of operations, and closure site conditions for the non-contact water diversion area are shown on Figure 3-14 through Figure 3-16, respectively. The non-contact water diversion area includes a variety of features and supporting infrastructure to divert non-contact water away from the tailings management site, generally including:

- Dikes
- Native soil fill areas
- Non-contact water ponds
- Non-contact water ditches
- Culverts

Reclamation of non-contact water diversion area features would generally include integration of non-structural features into the watershed as permanent landforms. Reclamation of the non-contact water diversion area would also include removal of physical structures (e.g., culverts) as appropriate to support future land use. Erosion control BMPs and general surface water controls to protect water quality to be applied throughout the closure stage are presented in Section 4.0. The general methods for restoration, typically consisting of landscape restoration and revegetation, are described in Section 5.0.

Table 3-3 provides an inventory of non-contact water diversion area features requiring closure and reclamation, and planned reclamation approach.

Table 3-3 Non-Contact Water Diversion Area Features for Closure

Feature Type	Name	Reclamation Approach
Non-contact Water Diversion	Dikes	Reclaimed during the construction stage and integrated into the permanent local watershed
	Native soil fill areas	
	Non-contact water ponds	
	Non-contact water ditches	
	Culverts	Manage in-place if service road is left in place for future land use; otherwise remove and sell, salvage, or dispose – regrade and revegetate as a permanent drainage channel

During the operations stage of the Project, a box culvert would convey non-contact water under the service road connecting the plant site and tailings management site. At the closure stage of the Project, the box culvert would be managed in place if the service road is needed to meet future land use plans. If the service road is not needed to meet future land use plans, the culvert would be removed and salvaged, recycled, or disposed, while the area previously occupied by the culvert would be converted to an open channel, reclaimed, and revegetated as a permanent drainage feature in the local watershed.

Design of non-contact water diversion area features would be developed to control erosion, and water runoff quality, quantity, and rates. Reclamation design would aim to create conditions where runoff rates and volumes estimated for runoff reaching downstream surface water receptors are similar to pre-mining site conditions. Post-closure grading plans and drainage features would be designed to limit flow velocities such that, together with vegetated cover, the resulting non-contact water diversion area would be stabilized with erosion potential generally similar to pre-mining site conditions.

3.5 Tailings Management Site

Typical existing, concurrent reclamation, end of operations, closure, and post-closure site conditions for the tailings management site are shown on Figure 3-17 through Figure 3-21, respectively. The tailings management site includes a variety of primary structures and supporting infrastructure, generally categorized as follows:

- Buildings at the TDP
  - Tailings thickener
  - Filter plant

  - E-house (electrical house), switch yard (electrical), and air compressors
  - Backfill plant
  - Filter cake storage and load-out building
- Pipelines, supporting equipment / infrastructure
- Lined dry stack facility
  - Liner system (including geomembrane liner, under-liner drain, over-liner drain, and blanket toe drain)
  - Groundwater cutoff wall (including a compacted soil seepage cutoff trench and, where needed based on site conditions, a grout curtain) (the groundwater cutoff wall is not shown on figures)
  - Compacted, dewatered tailings
  - Tailings cover system
  - Surface water management system (SWMS)
- Ponds
  - Contact water ponds
  - Settling / detention ponds
  - Emergency pond (at the TDP)
- Electrical / power
- Laydown / storage areas
- Service roads

Reclamation of primary tailings management site structures and supporting infrastructure would generally include leave in place, abandon in place, salvage or recycle (when practicable / feasible), demolition, or disposal. Reclamation of infrastructure types previously described in the Plan would generally follow the previously described reclamation sequence. Unique aspects of these reclamation sequences as applied to the tailings management site are summarized in the following sections. Surface water management at the tailings management site for the closure and post-closure stages of the Project is discussed in Section 3.5.9. Erosion control BMPs and general surface water controls to protect water quality to be applied throughout the closure stage are presented in Section 4.0. The general methods for restoration, typically consisting of landscape restoration and revegetation, are described in Section 5.0.

Table 3-4 provides an inventory of tailings management site features requiring closure and reclamation.

577 Table 3-4 Tailings Management Site Features for Closure

Feature Type	Name	Reclamation Approach
Buildings at the Tailings Dewatering Plant	Tailings Thickener	Remove and sell, salvage, recycle, or dispose – fill and regrade as necessary and revegetate
	Filter Plant	
	E-House, Switch Yard, and Air Compressors	
	Backfill Plant	
	Filter Cake Storage and Loadout Building	
Pipelines	Tailings	Remove and sell, salvage, recycle, or dispose
	Engineered Tailings Backfill	
	Process Water	
Lined Dry Stack Facility	Geomembrane and Soil Liner	Leave in place
	Blanket Toe Drain	
	Base Drain System	
	Seepage Cutoff Trench and Grout Curtain	
	Compacted Filtered Tailings	
	Tailings Cover System	Complete cover placement and revegetate
	SWMS	Complete SWMS and integrate into final closure drainage design
Ponds	Contact Water Ponds	Remove, fill and regrade as necessary, and revegetate (including converting to surface runoff drainage features or wetlands)
	Emergency Pond (at TDP)	
	Non-Contact Water Sedimentation / Detention Ponds (or alternate suspended solids management controls)	
Electrical / Power	Overhead Power Line From Plant Site to the Tailings Management Site	Sell, salvage, recycle, dispose, or leave in place per Section 3.3.3
	Power Distribution Within the Tailings Management Site	
Service Roads and Parking Areas	Service Roads	Leave in place until no longer needed, then regrade as necessary and revegetate; or mitigate as otherwise described per Section 3.3.1
	Parking Areas	

Feature Type	Name	Reclamation Approach
Stockpiles	Reclamation Material Stockpile	Reuse stockpiled material then regrade and revegetate the stockpile footprint
Laydown / Storage Areas	Laydown Areas	Regrade and revegetate

3.5.1 Tailings Dewatering Plant

TDP facilities (including the tailings thickener; filter plant; E-house, switch yard, and air compressors; backfill plant; and the filter cake storage and load-out building) at the tailings management site would be reclaimed at the closure stage of the Project using the general methods as described for other buildings, such as presented in Section 3.2.2. In summary, building content would be inventoried to identify materials and equipment for sale, salvage, recycling, or demolition and disposal. Tailings remaining in the tailings thickener would be removed and transported below grade to the underground mine area for mine backfill or be dewatered at the filter plant and transported to the lined dry stack facility. The filter equipment could have use by other mining operations, depending on equipment condition, and if so, would be cleaned, disassembled, and transported off site. The remaining unusable, salvageable, or recyclable portions of the buildings would be demolished, with demolition material properly disposed of, and then the site reclaimed using methods as previously described for plant site buildings.

3.5.2 Pipelines

At the end of the operations stage of the Project, the tailings supply lines (from the concentrator to the tailings thickener), engineered tailings backfill pipeline (from the backfill plant to the declines), and other associated tailings and process water pipelines not needed to continue management of contact water at the lined dry stack facility during the closure stage of the Project, would be flushed with clean make-up water to transport remaining tailings to the lined dry stack facility or a tailings management site contact water pond. Where possible, the pipelines would then be blown out, using compressed air and a pipe cleaning pig, to push make-up water remaining in the pipelines to a tailings management site contact water pond or to collection points where the water would be captured with a vacuum truck and then transported to the lined dry stack facility or an appropriate off-site disposal facility. Once emptied, pipelines would be removed. Pipeline segments would be disassembled and pipes would be salvaged and recycled or disposed of. Other pipelines used for contact water management during the closure stage of the Project, and possibly during the post-closure stage, would be managed using the same approach described, once they are no longer needed.

3.5.3 Lined Dry Stack Facility

Dry stack facility closure and reclamation is described by component in the following sub-sections of Section 3.5.3.

Dry Stack Facility Liner and Base Drain System

The lined dry stack facility would have a geomembrane and compacted soil liner, over-liner and under-liner drainage systems, blanket toe drain, and seepage cutoff and grout curtain constructed in increments, as needed for tailings storage through the life of the Project. This lined dry stack facility infrastructure would remain in place at closure.

During operations (including concurrent reclamation of the lined dry stack facility), dry stack facility draindown and seepage, if they occurred, would be collected and managed with the contact water system as described in the MPO. During the closure stage of the lined dry stack facility, the dry stack facility cover system would mitigate the generation of dry stack facility draindown and seepage. If draindown and / or seepage occurred and did not meet water quality requirements, and if planned management methods without treatment of water are no longer available, treatment technologies would be evaluated to identify additional management methods to meet water quality standards. Section 4.4 discusses water treatment. If draindown and / or seepage did occur and was shown by monitoring to meet surface water quality requirements, it would be routed to non-contact water ditches and discharged to the environment. The contact water ditches and contact water ponds would be reclaimed and revegetated as permanent drainage features. This would include constructing permanent channel outfalls from the contact water ponds to adjacent wetland complexes near the lined dry stack facility.

External Slopes and Dry Stack Facility Surface

The lined dry stack facility would include berms of densely compacted tailings placed on the dry stack facility perimeter to contain tailings-contact surface runoff, and draindown that may emanate from the dry stack during the operations stage of the Project and associated concurrent reclamation activities. Tailings placed on the perimeter, after completed to finished grade, would be concurrently reclaimed. The dry stack facility lined area would be constructed in three stages, generally starting on the west side of the dry stack facility nearest the TDP, and progressing eastward during the life of the Project. The perimeter berms would correspondingly be constructed in increments as tailings are generated and as needed to accompany dry stack facility liner construction and to provide the necessary liquid containment. The exterior face of the perimeter berms would be vegetated concurrent with their construction and BMPs, such as silt fences, erosion control mats and / or logs, and temporary mulch erosion controls, placed until vegetation became established. Therefore, the only reclamation required for the dry stack facility perimeter berms

would be associated with repair of areas disturbed by dry stack facility concurrent reclamation activities.

Conceptual Design of Dry Stack Facility Cover

Throughout the operations stage of the Project, areas of the lined dry stack facility would be filled to final grade and reclaimed. This concurrent reclamation approach would aid in:

- Minimizing particulate emissions from the stacked tailings;
- Minimizing infiltration of precipitation into the tailings and contact water runoff from the tailings, and the resulting generation of runoff and draindown requiring further management;
- Facilitating diversion of non-contact surface runoff to the environment following appropriate suspended solids removal; and
- Reducing financial assurance obligations upon final project completion.

For final dry stack facility operating areas, and other supporting operating areas within the tailings management site not concurrently reclaimed during the operations stage of the Project, reclamation would occur at the closure stage. Reclamation of the dry stack facility surface, whether concurrently or at the closure stage, would consist of fine grading of the tailings surface as needed, followed by placement of any required hydraulic barrier, a vegetation rooting media, then revegetated as described in Section 5.0. The perimeter of the lined dry stack facility fill area (within the tailings management site), which would have a relatively long 4 horizontal – to 1 vertical (4H:1V) finished slope at some locations, would incorporate intermediate non-contact water ditches to transfer runoff downslope and minimize erosion risk.

The filtered tailings placed in the lined dry stack facility would be compacted and placed at grades and contours that would promote drainage and minimize differential settlement and ponding, and would be designed to remain stable post-closure. The relatively flat tailings fill slopes (at 4H:1V and flatter) would aid in achieving and maintaining both operational and post-closure stability.

A cover system designed to function as a growth medium to support revegetation would be installed over the dry stack facility. The cover is anticipated to consist of a cover soil underlain by a hydraulic barrier. The type of hydraulic barrier would be selected based on future design evaluations that would assess compatibility with infiltration design criteria and availability of cover soil materials. Infiltration criteria would be determined based on future tailings geochemistry test work results and permitting requirements. At least 2 ft (0.6 m) of cover soil would be placed over the dry stacked tailings. Cover soil would be sourced from reclamation material stockpiles produced as part of tailings management site footprint development. If material stockpiled from initial site clearing is insufficient to meet volume requirements to establish the minimum 2 ft (0.6 m) soil cover, then supplemental cover soil would be imported once on-site material is consumed. Cover soil would be

seeded to establish grasslands per the final land use description provided in Section 11.0. Additional details on placement of cover soils and establishing a growth medium for revegetation is provided in Section 5.2.

Dry Stack Facility Surface Water Management for Non-Contact Water

The conceptual arrangement of surface water management at the lined dry stack facility during concurrent reclamation in the form of a site conceptual model (cross-section) is shown in Figure 3-22.

The contouring of the dry stack facility surface and placement of cover material would be done in a manner that promotes runoff and inhibits infiltration (e.g., avoid large surface depressions resulting in water ponding) to reduce (as far as practicable) the volume of contact water produced during dry stack facility construction. Tailings would be preferentially placed as part of operations and likely relatively little grading would be required to establish a finished slope towards the perimeter of the lined dry stack facility; this grading would occur as part of routine dry stack facility operations. Filling of the lined dry stack facility would generally be from west to east.

The placement of tailings at the lined dry stack facility would be managed to support concurrent reclamation of the facility. The lined dry stack facility would be incrementally filled to grade, and once covered, the non-contact surface runoff would drain to non-contact water ditches. The post-closure surface of the dry stack facility would be graded to drain toward the perimeter of the dry stack facility. Non-contact water runoff from the dry stack facility would be collected in non-contact water ditches on the exterior slope of the dry stack facility to convey water toward the toe of the dry stack facility perimeter embankment.

Initially (including during concurrent reclamation) the non-contact water ditches on the lined dry stack facility would drain to controls for removal of suspended solids. Controls for suspended solids removal may include temporary dedicated settling / detention ponds, contact water ponds, or other controls to be determined as part of future design. Water from non-contact water controls would drain to the environment following removal of suspended solids. Once the lined dry stack facility surface was fully revegetated and vegetation growth dense and well established, runoff may no longer require suspended solids removal to meet water quality standards. Once suspended solids removal is no longer necessary, runoff would be discharged directly to the environment. Water from contact water ponds would be managed as described elsewhere in this Plan.

Non-contact water ditches would be maintained throughout concurrent reclamation activities and would be integrated into permanent drainage features at the tailings management site during the closure stage of the Project. The non-contact water ditches that would be incorporated into the closed and reclaimed surface of the dry stack facility would reduce the uninterrupted flow length on the sloped areas of the

dry stack facility cover. Ditch revetment or riprap would be sized based on the range of flow velocities, flow depth, and channel shear stresses associated with the design storm event(s).

Once vegetation has matured on the dry stack facility surface, little erosion and siltation would be anticipated. As a result, for long-term closure, the temporary settling / detention ponds would be breached (or other suspended solids controls removed) and allowed to develop vegetation on a natural time scale and eventually develop into grasslands with no additional management. If controls other than settling / detention ponds are utilized, they would also be removed and the area they occupied would be reclaimed.

Leaving the lined dry stack facility largely in place in the final reclaimed landform would result in different drainage patterns compared to pre-mining conditions. Reclamation would include the use of surface water management features to control erosion and water runoff quality, quantity, and rates. Per state requirements, drainage would also be reintegrated into the natural watershed within three years of the start of closure.

Reclamation design would aim to create conditions where runoff rates and volumes are similar to runoff reaching downstream surface water receptors for pre-mining site conditions. Post-closure grading plans and drainage features would be designed to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting site would be stabilized with erosion potential generally similar to pre-mining site conditions. Stormwater would be collected in non-contact water ditches that discharge into the settling / detention ponds (or alternate controls) allowing for settlement of suspended solids before discharging to surrounding surface water receptors. The primary receiving water bodies downstream of the lined dry stack facility for non-contact water that meets surface water requirements would be Keeley Creek and the Birch Lake reservoir. Erosion control BMPs to be applied throughout reclamation are presented in Section 4.0.

3.5.4 Ponds

Ponds no longer needed at the tailings management site would be reclaimed in the same manner described in Section 3.2.8 for the Plant Site ponds. Ponds planned to remain would be reclaimed and revegetated as permanent drainage features. This would include constructing permanent channel outfalls from contact water ponds and settling / detention ponds to adjacent wetland complexes near the lined dry stack facility. Vegetation would be re-established per Section 5.0.

3.5.5 Electrical / Power

Unless a post-closure use is determined for the power lines between the plant site and the tailings management site, power lines and distribution facilities at the tailings management site would be dismantled (including the power line from the plant site

substation to the tailings management site) and reclamation performed in the manner previously described in Section 3.2.3.

3.5.6 Tailings Management Site Service Roads

Tailings management site service roads and associated infrastructure (e.g., parking areas) would be maintained in a form appropriate to provide access through the closure and into post-closure stages of the Project including access for monitoring. Once no longer needed for access, tailings management site service roads would be reclaimed. The reclamation approach would be similar to what is described for the Project access road in Section 3.3.1. The primary reclamation objective for the roads would be to provide long-term stabilization and surface water management consistent with the intended post-closure land use.

3.5.7 Reclamation Material Stockpile

Tailings management site reclamation material stockpiles would be closed by utilizing the stockpiled material to reclaim the lined dry stack facility surface and adjacent disturbed areas. Remaining reclamation material (if any) would be transported to the plant site to support reclamation activities. No reclamation material stockpiles would remain after the closure stage of the project.

The tailings management site reclamation material stockpile area would be regraded and re-vegetated as necessary to achieve desired surface runoff and re-vegetated surface conditions. Vegetation would be re-established per Section 5.0.

3.5.8 Laydown and Storage Areas

Saleable equipment and salvageable or recyclable materials in laydown and storage areas would be removed and transported off site. Other debris would be hauled to a licensed landfill for disposal.

Additional cover soil would be imported as needed and the laydown and storage areas would be regraded as necessary to restore, to the extent practicable, pre-mining surface runoff conditions. Vegetation would be re-established per Section 5.0.

3.5.9 Surface Water Management

The feature with overriding impact on surface water management within the tailings management site would be the lined dry stack facility. Surface water management is described in Section 3.5.3. Elsewhere within the tailings management site reclamation design, TMM would aim to create conditions where runoff rates and volumes estimated for runoff reaching downstream surface water receptors are similar to pre-mining site conditions. Post-closure grading plans and drainage features would be designed to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting tailings management site

would be stabilized with erosion potential generally similar to pre-mining site conditions. Additional details on placement of cover soils and establishing a growth medium for revegetation is provided in Section 5.2.

3.6 Other Supporting Infrastructure

Other supporting infrastructure would be removed or closed prior to or during the closure stage of the Project, unless required to support an agency-approved post-closure land use.

3.6.1 Drill Holes and Wells

TMM routinely seals their exploratory borings in accordance with requirements of Minn. R., part 4727.1000 through 4727.1250 and additional Minn. R. referenced therein. At the closure stage of the Project, temporarily sealed boreholes would be scheduled for permanent sealing within 10 years of temporary seal installation. Borehole permanent sealing would be scheduled to occur as soon as practicable within this 10-year window. For example, an exploratory borehole installed and temporarily sealed 4 years prior to closure would be permanently closed within 6 years of initiation of closure, but possibly sooner, dependent on the number of wells needing permanent closure.

Wells (including monitor wells, water supply wells, and piezometers associated with the Project) not needed for post-closure monitoring would be plugged and abandoned by a licensed well driller in accordance with applicable state rules (e.g., Minnesota Department of Health [MDH]) and local requirements.

Many drill holes and wells would be sealed and plugged concurrent with the operations stage of the Project when determined to have no future use. A plan describing drill hole and well abandonment procedures and locations would be developed prior to the construction stage of the Project and then would be routinely updated to document new and abandoned locations. Plans for monitor well, water supply well, piezometer, and / or exploratory borehole abandonment required to be established during initial permitting of these installations would be followed and may supplant the need for further action and / or supersede requirements of this Plan.

Access roads and drill pads authorized by the MDNR, and U.S. Forest Service (USFS) where required, would continue to be decommissioned in accordance with specific requirements of TMM's associated Plan of Operation for the specific drilling activities to be performed, and per requirements of the corresponding Stipulations to Federal Hardrock Minerals Prospecting Permits. These permits are on file with the authorized regulatory agencies and with TMM, and the corresponding stipulations are not repeated herein.

3.6.2 Fencing

Prior to final reclamation, installed fences around the plant site, tailings management site, and other Project locations would be removed, unless otherwise deemed necessary to support an agency-approved post-closure land use or ongoing access restriction.

3.7 Material Disposal

3.7.1 Product Disposal

Product (concentrate) would be shipped to customers. If product cannot be shipped, such as that recovered from pre-demolition building clean-up, it would be disposed in an appropriate off-site landfill.

The reagent suppliers, which would be under contract to TMM, would remove reagents remaining at the closure stage of the Project. In many cases, the suppliers of chemicals and equipment would be responsible for furnishing tanks and would therefore also be required to remove and dispose of those tanks during closure.

3.7.2 Demolition Waste Disposal

It is anticipated the majority of the demolition waste (material not salvageable, saleable, recyclable, or reusable) from removal of structures would be acceptable for disposal in a new (location to be determined) or existing demolition debris landfill. Concrete from demolition, with the exception of oil-stained concrete, would be crushed and used for on-site structural fill for closure, placed in building basements where possible, or placed in landfills as required. Oil- or chemical-stained concrete would be managed as solid waste.

3.7.3 Solid Waste and Industrial Solid Waste Disposal

Solid waste and industrial solid waste would be managed per the requirements of Minn. R., chapter 7035. Solid waste and industrial solid waste, not recyclable or of other suitable alternate end use, would be disposed of in a permitted solid waste or industrial solid waste land disposal facility.

3.7.4 Special Material Disposal

For this Plan, special materials is defined as those materials not classified as demolition debris, not classified as solid waste, and not a RCRA-regulated material. Management of special materials may be governed by local ordinance and / or by a subpart of Minnesota Pollution Control Agency (MPCA) solid waste rules. Special materials on site at the time of closure may include nuclear sources, partially used paint, chemical and petroleum products, fluorescent and sodium halide bulbs,

batteries, electronic waste, lighting ballasts, and small capacitors. These materials would be safely collected, removed, and properly recycled or disposed.

Nuclear sources would be disposed in accordance with U.S. Nuclear Regulatory Commission (USNRC) regulations, as regulated by the MDH pursuant to their 2006 agreement with the USNRC.

Partially used paint, chemical, and petroleum products would be collected and properly recycled or disposed.

Fluorescent and sodium halide bulbs would be removed from fixtures, collected, and properly disposed.

4.0 WATER QUALITY

4.1 Erosion Control BMPs

Erosion control BMPs would be implemented concurrent with the seeding and revegetation processes. In seeded areas with slopes of 4H:1V or flatter, mulch would be applied. Mulching material would consist of straw, prairie hay, or other suitable mulch type, and would be applied uniformly over the soil surface within 24 hours after seeding. Immediately after placement, mulch material would be anchored into the soil by crimping (straight disking) in a direction perpendicular to the overland stormwater flow.

In seeded areas with slopes steeper than 4H:1V, mulch, biodegradable erosion control blankets, or other BMPs would be installed. If erosion problems impacting the ability to achieve overall reclamation objectives occur, then other controls would be evaluated and implemented as appropriate based on the observed conditions, root cause of the erosion, and reclamation goals targeted.

The Project would meet sediment yield requirements as per Minnesota Permit MN R100001, consisting of the state-wide National Pollutant Discharge Elimination System (NPDES) / State Disposal System (SDS) Construction Stormwater Permit for discharges of stormwater from areas of land disturbance during reclamation activities (where stormwater has not mixed with contact water). BMPs for the Project would include erosion and sediment controls, conveyance, stormwater diversions, and treatment structures, in addition to procedures used to minimize the exposure of stormwater to pollutants or to remove pollutants from stormwater.

4.2 Groundwater Quality

The groundwater quality monitoring network, sampling schedule, and analytical parameters established for permit compliance would be reviewed as part of closure

planning – generally within 12 to 18 months prior to planned closure. The purpose of the review would be to:

- Identify groundwater quality monitor wells for which sampling can cease at the time of planned closure;
- Identify changes to the analytical parameter list that can be made at the time of planned closure; and
- Identify modifications to the groundwater quality monitoring schedule that can be implemented at the time of planned closure.

One or more of the changes noted may be warranted due to the decreased risk to the environment presented by the post-closure condition in comparison to the routine operating condition.

Post-closure review of the groundwater quality monitoring network, sampling schedule, and analytical parameters list would occur periodically and at minimum once every other year during the first 10 years of closure, and once every 5 years thereafter, unless mutually agreed otherwise by TMM and the MPCA, through negotiation or by permit condition.

4.3 Surface Runoff Control

Surface runoff originating from the interior dry stack facility surface would be collected and used as described in the MPO or possibly discharged underground at the mine site (assuming it meets discharge standards).

Surface runoff quality would be managed after closure and reclamation to meet applicable surface water quality standards. Surface runoff from the reclaimed dry stack facility surface and embankment slopes would be contained in settling / detention ponds when necessary. The settling / detention ponds would remove suspended sediments from the runoff prior to discharge to the environment.

The proposed restoration of the plant site and corridor surfaces to generally mimic pre-mining conditions would result in runoff water quality similar to pre-mining conditions.

A surface runoff sampling plan would be developed 12 to 18 months prior to planned closure, then implemented at the Closure stage of the Project to confirm compliance with surface water quality standards.

4.4 Water Treatment

TMM anticipates closure of the Project with no need for water treatment and associated surface water discharge permit. Further test work and engineering analyses of tailings geochemistry and the overall site water balance is required to verify this conclusion. If test work and engineering analyses show water treatment or

other water management methods are required, then water treatment systems and management methods would be evaluated and designed as part of future studies. Should water treatment or another management method be necessary, this Plan would be updated to address closure and reclamation of water treatment systems.

5.0 REVEGETATION

Revegetation during the operations stage (concurrent reclamation) and the closure stage would be carried out according to the information and data obtained from studies related to revegetation initiated at the start of mining, including studies of seed mixtures, growth media, and soil amendments. Existing land cover at the plant site and lined dry stack facility are shown on Figure 5-1.

5.1 Reference Sites and Revegetation Test Plots

Reference sites (areas to be undisturbed by the Project) would be identified, evaluated, and selected prior to mining as a method to monitor and document pre-mining vegetation type and quality at various locations on the Project (i.e., plant site, corridors, and the tailings management site) and natural variation in vegetation type and quality over time. Monitoring at reference sites would not only aid in developing concurrent-reclamation and closure-stage-reclamation-vegetation type and quality targets, but also make it easier to judge when revegetation could be considered complete.

5.2 Soil Preparation / Management

During concurrent reclamation and the closure stage of the Project, salvaged or manufactured growth media (a material having sufficient combinations of organic, mineral, and nutrient content to sustain vegetation) would be placed over the surface of the areas to be reclaimed. Growth media would be salvaged and stockpiled during the construction stage of the Project. If additional growth media is required, then it would be manufactured on site by mixing stockpiled inorganic mineral soil with organic soil / peat salvaged during the construction stage of the Project or it would be imported from off-site borrow sources as appropriate. Revegetation test plots would be used to test a range of growth media thicknesses.

At the tailings management site, a plant growth medium (reclamation material / topsoil) would be placed on top of dry stack facility areas, as part of concurrent reclamation, and as part of remaining closure stage reclamation activities. The dry stack facility subsoil materials would be shaped to facilitate proper drainage.

Through the process of stripping and stockpiling, essential soil microbes are destroyed. Their presence would be essential to vegetation establishment success. Restoration of soil microbes would occur through a two year sequence of cover cropping prior to planting the final perennial cover as described in Section 5.3.

5.3 Plantings

Plant communities selected for revegetation would be confirmed based on reference site and revegetation plot findings. Until then, plant communities have been selected considering climate change and the anticipated evolution of plant communities in the project region. These native plant communities are expected to readily establish and evolve on the site.

Target plant communities would include:

- Lined Dry Stack Facility: Diverse grasslands with pollinator species;
- Plant Site: Range of mixed hardwood pine forest to jack pine barrens;
- Non-contact water diversion area: Drainage features and a range of mixed hardwood pine forest to jack pine barrens; and
- Corridors: Range of mixed hardwood pine forest to jack pine barrens (unless an alternate future use is identified for the corridor and / or infrastructure).

Seed mixes along with a cover crop would be planted as soon as practicable after growth medium is placed, to quickly establish and to provide comprehensive cover that would help mitigate erosion. It would also provide a diversity of species that can thrive on site and would provide valuable wildlife habitat for birds, insects, reptiles, and mammals.

Scheduling of reclamation activities would occur as soon as possible after the mining activities in an area are completed, thus minimizing erosion and sedimentation. General scheduling procedures to be followed would include, but would not be limited to, the following:

- Grading, drainage control establishment, and maintenance would be conducted in late spring to late summer;
- Seedbed preparation would be conducted prior to seeding; and
- Seeding would preferably be completed in mid to late fall or in winter.

In some cases, early to mid-spring seeding would take place when weather constraints or other unavoidable circumstances preclude fall seeding.

During the life of the mine, concurrent reclamation and interim reclamation would be performed wherever possible, to reduce erosion and weed invasion. The remainder of the revegetation would occur following the cessation of site activities.

5.4 Revegetation Success Criteria

TMM anticipates proposing revegetation success criteria consistent with Minn. R., part 6132.2700 Vegetation, which generally require:

- Evaluate the vegetation growth on the reclaimed facilities for ten seasons. The evaluations would consist of field measuring established transects for percent ground cover and species composition. Sampling would be conducted at the "peak green season;"
- After three growing seasons, revegetation would be considered successful if there is 90% ground cover within a 90% confidence interval, consisting of living vegetation and its litter. Within 10 growing seasons following the initiation of vegetation, the vegetative community would have characteristics similar to those of the approved reference sites. After the evaluation and documentation that the revegetation standards for the project have been achieved, TMM would request the release from permit obligations related to revegetation; and
- If revegetation standards for a site have not been achieved, TMM would evaluate the best course of actions necessary to meet the reclamation goals. If appropriate, seeding would again be conducted during the upcoming season.

During vegetation establishment, selective weed control practices would be implemented to limit the growth and spread of noxious weeds and to ensure revegetation is successful.

To meet vegetation management goals, periodic site evaluations during the growing season (May-October) are critical during the first few years of vegetation establishment. Monitoring is useful in identifying issues, tracking progress, and reevaluating management needs.

A site evaluation and vegetation maintenance plan for each site visit would be produced each year in June and may include:

- Issues observed with vegetation establishment such as compacted soils, failure of seeding and / or invasive species encroachment;
- Proposed management activities;
- Schedule of management activities;
- Issues with stormwater management such as flooding; and
- Issues with soil management such as erosion or new ground disturbance.

Vegetation monitoring would be differentiated between an establishment phase (1 to 3 years) and a maintenance phase (3+ years).

5.5 Wildlife

Revegetation plans would proceed as described in Sections 5.2 through 5.4 and on the basis of reference site and revegetation plot outcomes. Wildlife are supported and sustained by existing site conditions, and are expected to naturally remain throughout the mining operation due to the limited extent of the planned surface

disturbance. Post-closure conditions would gradually mimic surrounding conditions and therefore should support a similar diversity and density of wildlife as compared to pre-mining site conditions.

6.0 RECLAMATION EQUIPMENT AND RESOURCES

TMM would rely on local and regional consultants and contractors for implementation of this Plan. There are no specialized skills or expertise required for Plan implementation not available locally and regionally. In addition to engineering and science personnel normally engaged to plan and support reclamation, local and regional construction contractors would also be utilized for removal / demolition of Project infrastructure and for closure of infrastructure described within this Plan. Typical contractor services and equipment required and readily available include:

- Erosion control contractors
- Earthwork contractors
- Demolition contractors
- Licensed well drillers
- Electricians
- Surveyors
- Waste management contractors (recycling, solid waste, hazardous waste)
- Landscape / seeding contractors

There would be no specialized equipment needed to implement requirements of this Plan. Plan implementation would be by local / regional contractor direct hire and competitive bidding as determined by TMM.

7.0 VARIANCE FROM RULES

TMM does not currently anticipate the need for rules variances to implement this Plan. As Project definition and design progress, variances from rules may be identified and would be added to future Plan updates. Requests for variance from Minn. R., part 6132.3200 Closure and Post-closure Maintenance requirements would be formally prepared and submitted per requirements of Minn. R., part 6132.4100 at the time application is made for a PTM.

8.0 CLOSURE TIMELINE

8.1 Planned Closure

Per Minn. R., part 6132.0100, closure means the process of terminating and completing final steps in reclaiming any specific portion of a mining operation. Closure begins when there would be no renewed use or activity by the permittee. In this Plan, concurrent reclamation is reclamation that occurs during the operations

stage of the Project. Other reclamation activities would take place during the Closure stage of the Project.

Planning for closure and reclamation would be an on-going process that results in progressive updates to this Plan based on environmental review, permitting, design, construction, and operations. Closure planning studies would start well before the end of the operations stage of the Project in order to provide the necessary information to inform reclamation approaches that would successfully achieve reclamation requirements, including requirements of Minn. R., part 6132.3200 (for brevity, rules are not repeated herein). During the closure stage, a closure team would be required to manage reclamation and closure activities within the Project.

A summary of the reclaimed Project components, the general reclamation approach for each component, and an estimated schedule for the closure and post-closure maintenance stages of the Project is provided in Attachment B.1. The schedule is provided in terms of closure years (i.e., closure year 1) and is not assigned a calendar year at this time. This schedule would be updated when the permitting process is sufficiently advanced to estimate a beginning date for the operations stage of the Project.

8.2 Temporary Closure

In the event continuous, full-scale production is interrupted due to economic considerations or unforeseen circumstances, temporary closure and interim reclamation may be initiated. Temporary closure would be implemented in accordance with requirements of Minn. R., part 6132.3200, subpart 2.

Several approaches may be necessary to plan for temporary closure. There are differences between long-term and mid-term plans, with a mid-term plan utilizing a strategy assuming commodity prices or other issues would recover reasonably quickly. However, commodity price movements cannot be accurately predicted with certainty. Therefore, even with the mid-term closure scenario, it is prudent to plan for the possibility prices do not recover quickly and long-term closure may eventually be the best option.

Some temporary closure actions may be similar to final closure actions, while others would be different based on an objective to maintain the mine in a state suitable for resumption of operation at a later date. These various objectives would be carefully considered and reevaluated as necessary or if new information arose.

Interim reclamation for various categories of infrastructure would include:

- Mine Ventilation and Access – mine ventilation would continue only as may be needed for temperature and humidity control to protect in-mine infrastructure. The mine portal and declines would be secured as necessary to prevent unauthorized access;

- Process Facilities – applicable process facilities and support systems would be maintained in a condition conducive to reasonably rapid restart;
- Power Lines – power lines would be inspected regularly and maintained as necessary;
- Roads – the access road and service roads would receive maintenance, as necessary;
- Erosion Control Measures – erosion control measures and BMPs would be regularly inspected and maintained;
- Buildings – buildings, equipment, and support facilities would be protected from public access and maintained as necessary;
- Pipelines – pipelines would be drained of contents to the extent feasible and placed in an idle operating condition;
- Lined Dry Stack Facility – the lined dry stack facility would remain open and available to restart, with liquids collection and dust control continued as needed until routine operations resume – some areas may receive temporary cover; and
- Environmental Monitoring – required environmental monitoring would continue.

Infrastructure would undergo routine drive-by inspection, with on-ground detailed inspection as needed, to confirm systems remained in their intended temporarily closed condition, and no vandalism or unauthorized access had occurred.

8.3 Contingency Closure

If operations ceased prior to the planned closure date, some of the actions included in this Plan could require modification appropriate to the conditions existing at the time of unplanned closure. These modifications would be documented in a final closure plan prepared at that time.

The first-year Reclamation Plan would require establishment of financial assurance commensurate with the liabilities existing at the time of Plan issuance and anticipated to accrue through the first year of Project implementation. Financial assurance obligations would be tabulated and costs estimated at the time project permitting has progressed to the point where the final project has been confirmed and generally accepted, though not yet fully permitted, by the appropriate regulatory agencies. For this Plan the BLM and the MDNR are anticipated to have primary responsibility for Plan approval, with the MDNR having primary responsibility through their PTM process for establishment of financial assurance mechanisms and dollar amounts. Adequacy of financial assurance would be reviewed and updated on an annual basis in conjunction with preparation of the annual report required by the MDNR PTM.

9.0 CLOSURE DOCUMENTATION AND REPORTING

Concurrent with preparation of the application for MDNR PTM, TMM would update this Plan as needed to account for the Planned Closure, Temporary Closure, and Contingency Closure of the final project design and infrastructure. Implicit within the Plan would be compliance with Minn. R., part 6132.3200 for Closure and Post-closure Maintenance. A tabular summary of infrastructure and equipment and corresponding closure requirements would be prepared to support permitting and establishment of financial assurance. Closure documentation and reporting would be to the MDNR, with a completed tabular summary, photographic documentation, and cost accounting for planned, temporary, and contingency closure required. A written summary of any special closure conditions and maintenance requirements and listing of responsible parties would accompany the closure documentation and reporting. The report would generally be submitted consistent with the established annual report submittal timeline, unless an alternate timeline were established by conditions of the PTM.

10.0 POST-CLOSURE MAINTENANCE, MONITORING, AND REPORTING

Objectives for closure incorporated in this Plan include restoration to pre-mining conditions to the extent practicable and desirable, continued protection of human health and the environment, and the minimization of post-closure maintenance and monitoring requirements. During the post-closure period, personnel would be retained, or subcontracted as required, to manage reclamation maintenance and monitoring activities within the Project.

10.1 Maintenance and Monitoring

Anticipated post-closure maintenance activities are listed in Table 10-1. Content in this table would be updated as Project definition is refined through environmental review, design, and permitting. The Project would be closed with the objective of minimizing post-closure inspection, maintenance, and monitoring activities. Closure objectives would vary between different sites encompassing the overall Project footprint.

1195 Table 10-1 Post-Closure Maintenance and Inspection

Site	Maintenance Item / Activity	Duration	Reference Section(s)
Underground Mine Area	Vegetation monitoring (at ventilation raise site reclaim areas)	Until success criteria are satisfied	5.4
	Ventilation raise site closures – confirmation of closure integrity and absence of ground subsidence	Twice annually – post-closure stage years 1 through 3	n/a
Plant Site	Vegetation monitoring	Until success criteria are satisfied	5.4
	Confirmation of surface runoff and erosion control performance	Twice annually during post-closure stage years 1 through 3, plus following severe rain events	n/a
Non-Contact Water Diversion Area	None planned as the non-contact water diversion area would be reclaimed during the operations stage of the Project	n/a	n/a
Corridors	Vegetation monitoring	Until success criteria are satisfied	5.4
	Confirmation of surface runoff and erosion control performance	Twice annually during post-closure stage years 1 through 3, plus following severe rain events	n/a

Site	Maintenance Item / Activity	Duration	Reference Section(s)
Tailings Management Site	Vegetation monitoring	Until success criteria are satisfied	5.4
	Confirmation of surface runoff and erosion control performance, with runoff and erosion repair until erosion no longer occurs	Twice annually during post-closure stage years 1 through 3, plus following severe rain events, once annually thereafter plus following severe rain events through duration of post-closure stage	n/a
	Lined dry stack facility draindown and seepage water management	Until draindown and seepage (if they occur) ceases or applicable water quality standards are met	n/a
	Confirmation of dry stack facility cover system integrity	Initiated if, post-closure, there is initiation of and / or an increasing trend in quantity of draindown and seepage at the lined dry stack facility	n/a
	Water quality monitoring (wells and surface water stations)	Until applicable water quality standards are met without treatment (e.g., treatment for removal of suspended solids)	n/a
	Piezometers and inclinometers	As specified by dry stack facility geotechnical engineer	n/a

The dry stack facility cover system would mitigate the generation of dry stack facility draindown and seepage. If post-closure draindown and / or seepage did occur, it would be managed using approaches described in Section 3.5.3.

10.2 Reporting

Anticipated post-closure reporting activities are listed in Table 10-2. Because the Project would be closed with the objective of minimizing post-closure inspection, maintenance, and monitoring activities, post-closure reporting obligations would also be minimized.

Table 10-2 Post-Closure Reporting

Site	Documentation and Reporting	Frequency of Reporting
Underground Mine Area	Vegetation density, condition, and type	Post-closure years 1 - 5
	Surface runoff controls	Post-closure years 1 - 5
	Ventilation raise sites closure condition	Post-closure years 1 - 3, 5-year increments thereafter to year 25
Plant Site	Vegetation density, condition, and type	Post-closure years 1 - 5
	Surface runoff controls	Post-closure years 1 - 5
	Portal closure condition	Post-closure years 1 - 3, 5-year increments thereafter to year 25
Non-Contact Water Diversion Area	None planned as the non-contact water diversion area would be reclaimed during the operations stage of the project	n/a
Corridors	Vegetation density, condition, and type	Post-closure years 1 - 5
	Surface runoff controls	Post-closure years 1 - 3
Lined Dry Stack Facility Site	Vegetation density, condition, and type	Post-closure years 1 - 5
	Water quality1	Post-closure years 1 - 25
	Surface runoff controls	Post-closure years 1 - 25

[1] In compliance and coordination with NPDES and other applicable permits.

Findings from post-closure inspections would be incorporated into annual reporting as required by the PTM.

11.0 FUTURE LAND USE RESTRICTIONS

Future land uses would be restricted in the following primary areas:

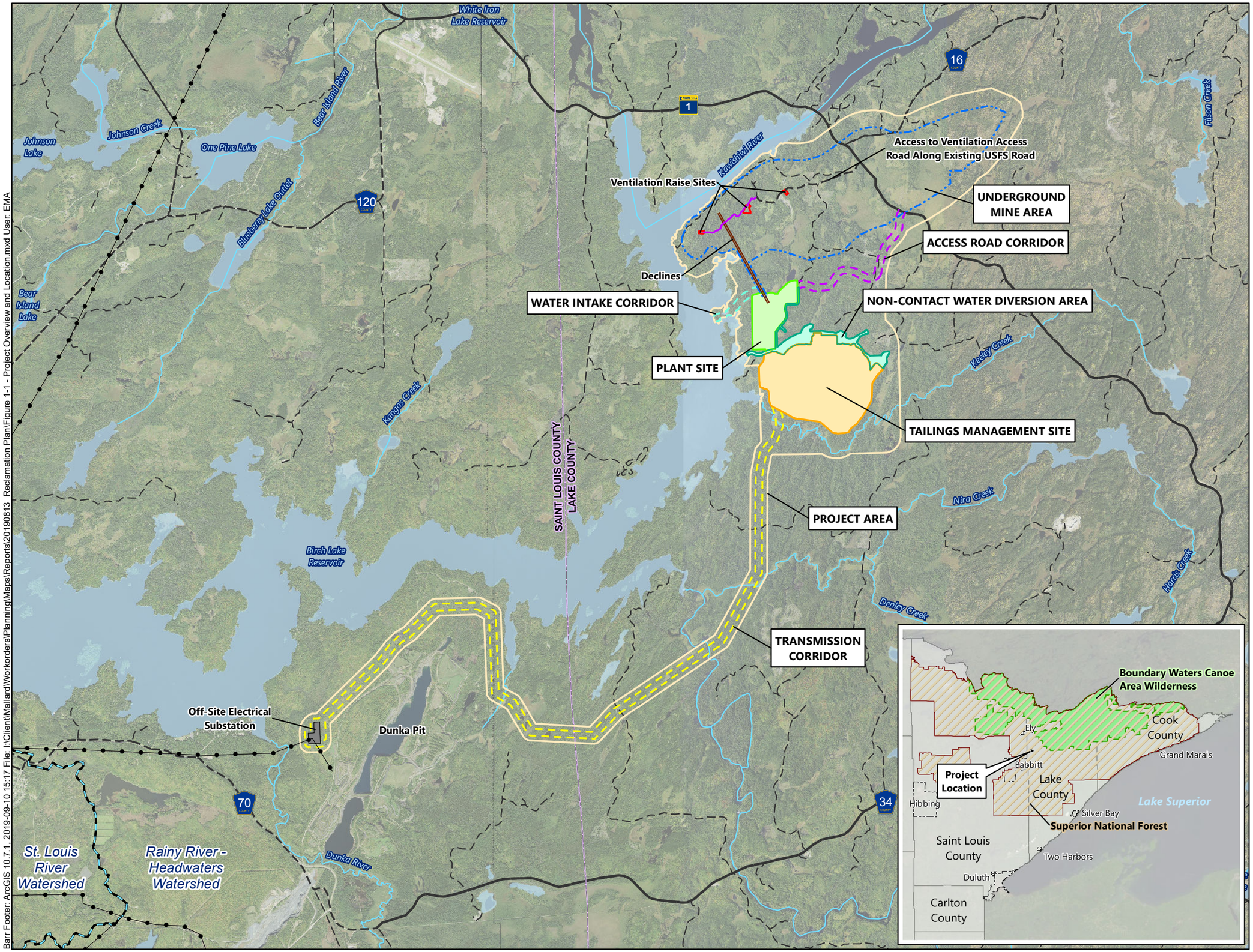
- Closed ventilation raise site locations;
- Closed mine portal location; and
- Closed dry stack facility.

At the ventilation raise sites and mine portal locations, the proposed land use presented in Section 2.2 would be matched to the anticipated final ground condition at the Closure stage of the Project. At the ventilation raise sites and mine portal locations, heavy loads from large structures would be prohibited. Such loads could, in an extreme case, cause subsidence of the ventilation raise closure systems and, though highly unlikely, the mine portal closure. At ventilation raise sites and mine portal access locations the near-surface closure systems would be of high strength and durability, but subsurface excavations even at these locations by large construction equipment as might occur for a large-scale structure could damage the

closure systems. Deed restrictions would be established to ensure future land owners were informed of these land use constraints.

The tailings stored at the lined dry stack facility, though compacted during placement, could have some potential for post-closure differential settlement, and further, may have insufficient bearing capacity to support sizeable structures. Therefore, placement of infrastructure atop the closed dry stack facility would likely be limited to relatively low ground pressure, settlement tolerant structures.

FIGURES



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Transmission Corridor
Water Intake Corridor
Ventilation Raise Site
Electric Substation
Declines
Ventilation Raise Access Road
Existing Powerline
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
Watershed - DNR Level 4
County Boundary
USFS Roads (2013)
Streets and Highways (MnDOT)
State Trunk Highway
County State-Aid Highway

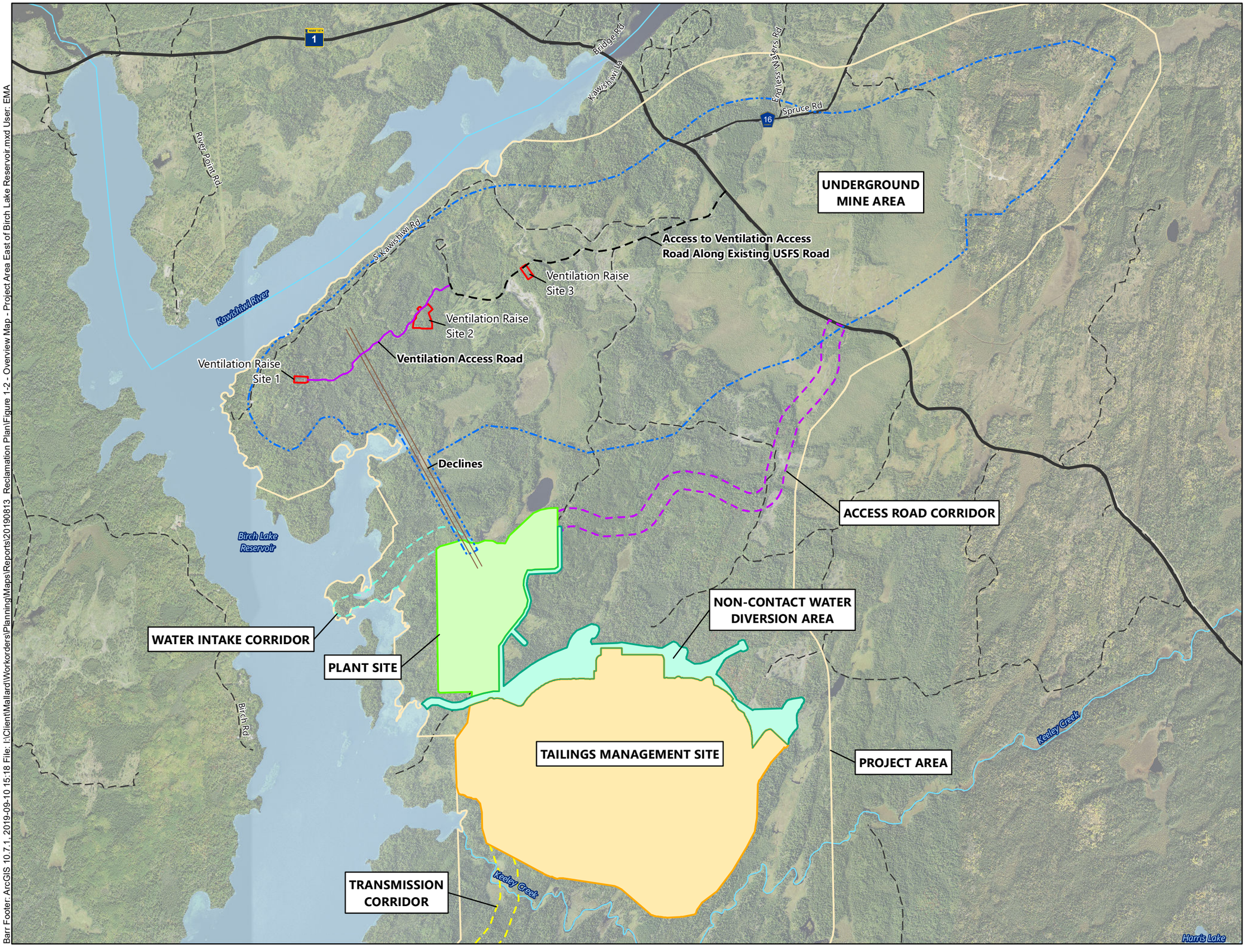
N

0 0.5 1 2
Miles

0 0.5 1 2
Kilometers

Figure 1-1
PROJECT OVERVIEW AND LOCATION
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:17 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 1-1 - Project Overview and Location.mxd User: EMA



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Transmission Corridor
Water Intake Corridor
Ventilation Raise Site
Declines
Ventilation Raise Access Road
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
USFS Roads (2013)

Streets and Highways (MnDOT)

State Trunk Highway
County State-Aid Highway

Note: The underground mine area is roughly 3.9 miles long by 1.2 miles wide. The initial haulage tie-in point to the mine decline is approximately 1,170 feet below the portal collar elevation while the lowest stope centerline development is approximately 4,470 feet below the portal collar elevation.

N

0 1,000 2,000 4,000
Feet

0 300 600 1,200
Meters

Figure 1-2
OVERVIEW MAP - PROJECT AREA EAST OF BIRCH LAKE RESERVOIR
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:18 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 1-2 - Overview Map - Project Area East of Birch Lake Reservoir.mxd User: EMA

ACCESS ROAD CORRIDOR
Access Road
Security/Guard Shack
Snow Storage
Reclamation Material Stockpile 1
NON-CONTACT WATER DIVERSION AREA
TAILINGS MANAGEMENT SITE
Waste Storage Area
Tire Wash
Parking
Propane Storage Tank
Bus Loop
Mine Services Building
Site Road
PLANT SITE
Overhead power-line from the off-site substation to plant site substation and from plant site substation to the TMS.
North Contact Water Pond
Snow Storage
Diesel Fuel
Reclamation Material Stockpile 2
Shotcrete Plant & Aggregate Stockpile
Engineered Tailings Backfill Pipeline
Substation
Propane Storage Tank
Ball Storage
Mine Water Tank
Portals
Coarse Ore Stockpile
Conveyor
Concentrator
Tailings Pipeline
UNDERGROUND MINE AREA
Sediment Pond
Service Building
Process Water Tank
Fresh Water and Fire Water Tank
Snow Storage
Overflow Ore Stockpile
Process Water Pond
South Contact Water Pond
Storage
Access Decline
Conveyor Decline
TRSF Lined Area and Ditches
Explosive Magazine
Central Contact Water Pond
Reagent Storage
Concentrator Services Building
Bus Loop/Parking
WATER INTAKE CORRIDOR
Water Intake Pipeline, Maintenance Access Road, Underground Power, and Communication
Birch Lake Reservoir

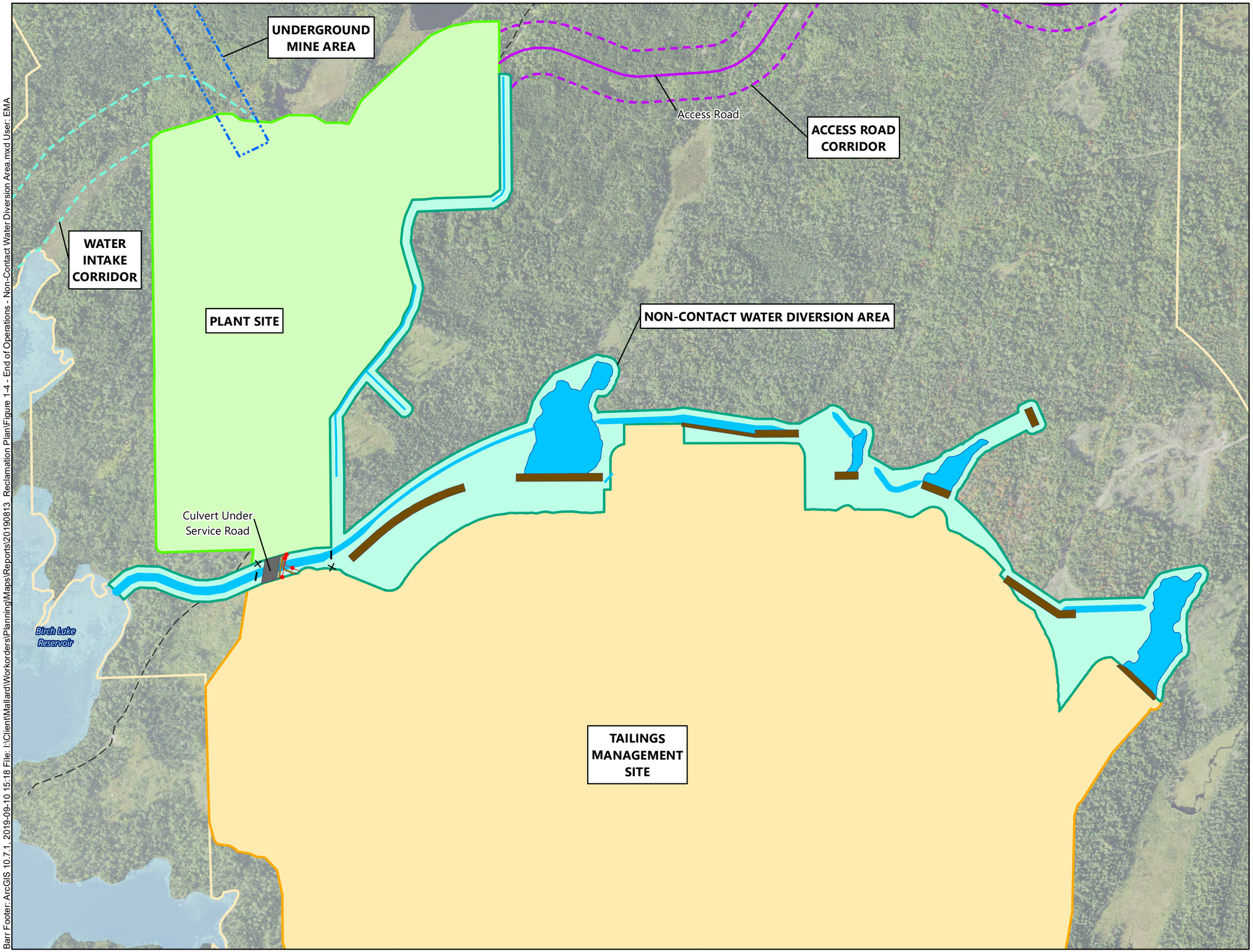
Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Road
Transmission Line
Equipment/Infrastructure
Fenceline
Water Intake Pipeline
Project Contours
Building
Contact Water Pond
Electrical/Power
Equipment/Infrastructure
Fuel Storage
Laydown/Pad/Storage
Reclamation Material Stockpile
Service Road/Parking
Stockpile
Tailings Pipeline
PWI Basin (MNDNR 2017)
USFS Roads (2013)

N

0 175 350 700
Feet
0 50 100 200
Meters

Figure 1-3
END OF OPERATIONS - PLANT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1 2019-09-13 10:53 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Reclamation Plan\Figure 1-3 - End of Operations - Plant Site.mxd User: EMA



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Road
Transmission Line
Fenceline
Dike
Non-Contact Water Ditch (NWD)
Non-Contact Water Pond (NWP)
Service Road/Parking
Tailings Pipeline
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
USFS Roads (2013)

N

0 350 700 1,400
Feet

0 100 200 400
Meters

Figure 1-4
END OF OPERATIONS -
NON-CONTACT
WATER DIVERSION AREA
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:18 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 1-4 - End of Operations - Non-Contact Water Diversion Area.mxd User: EMA

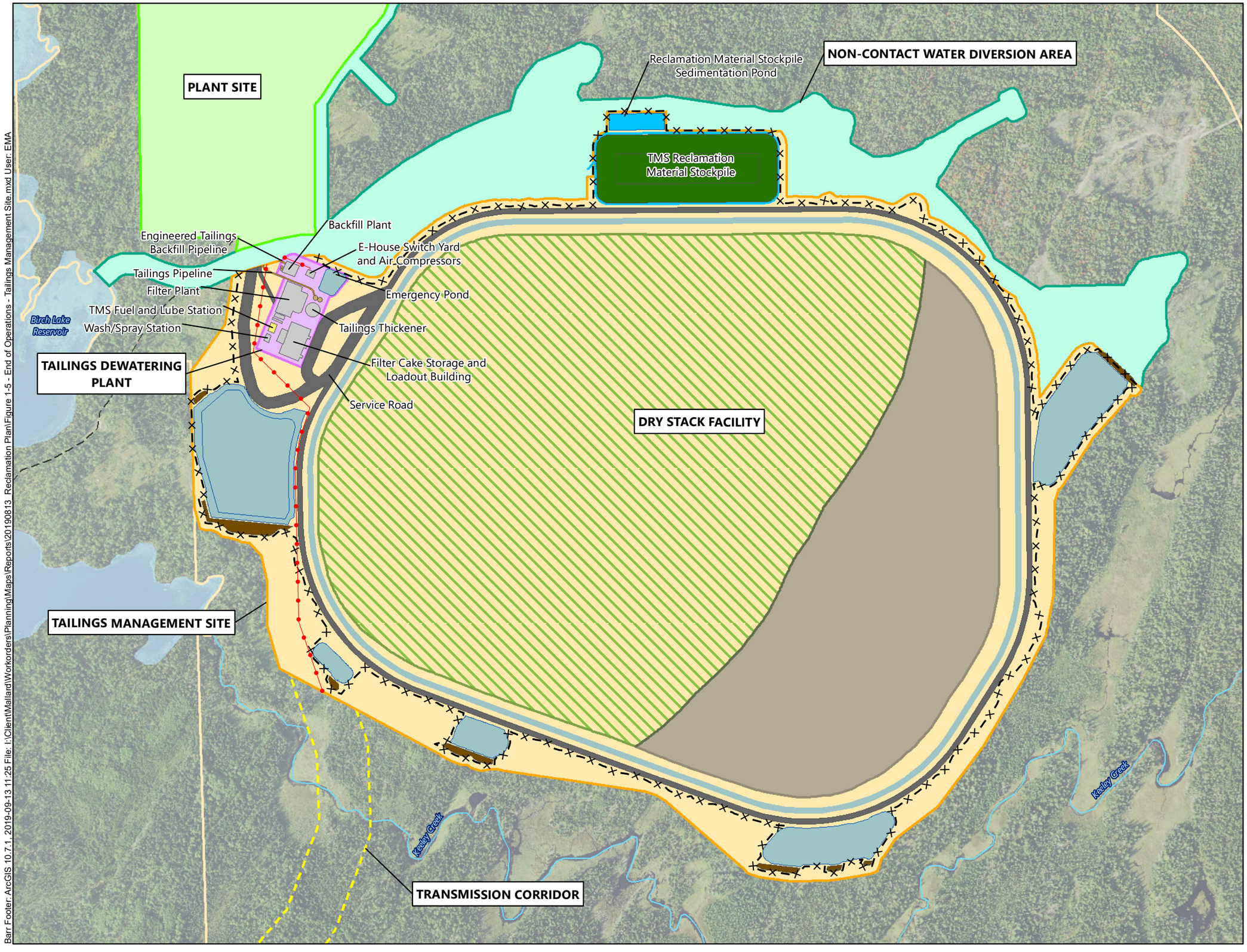
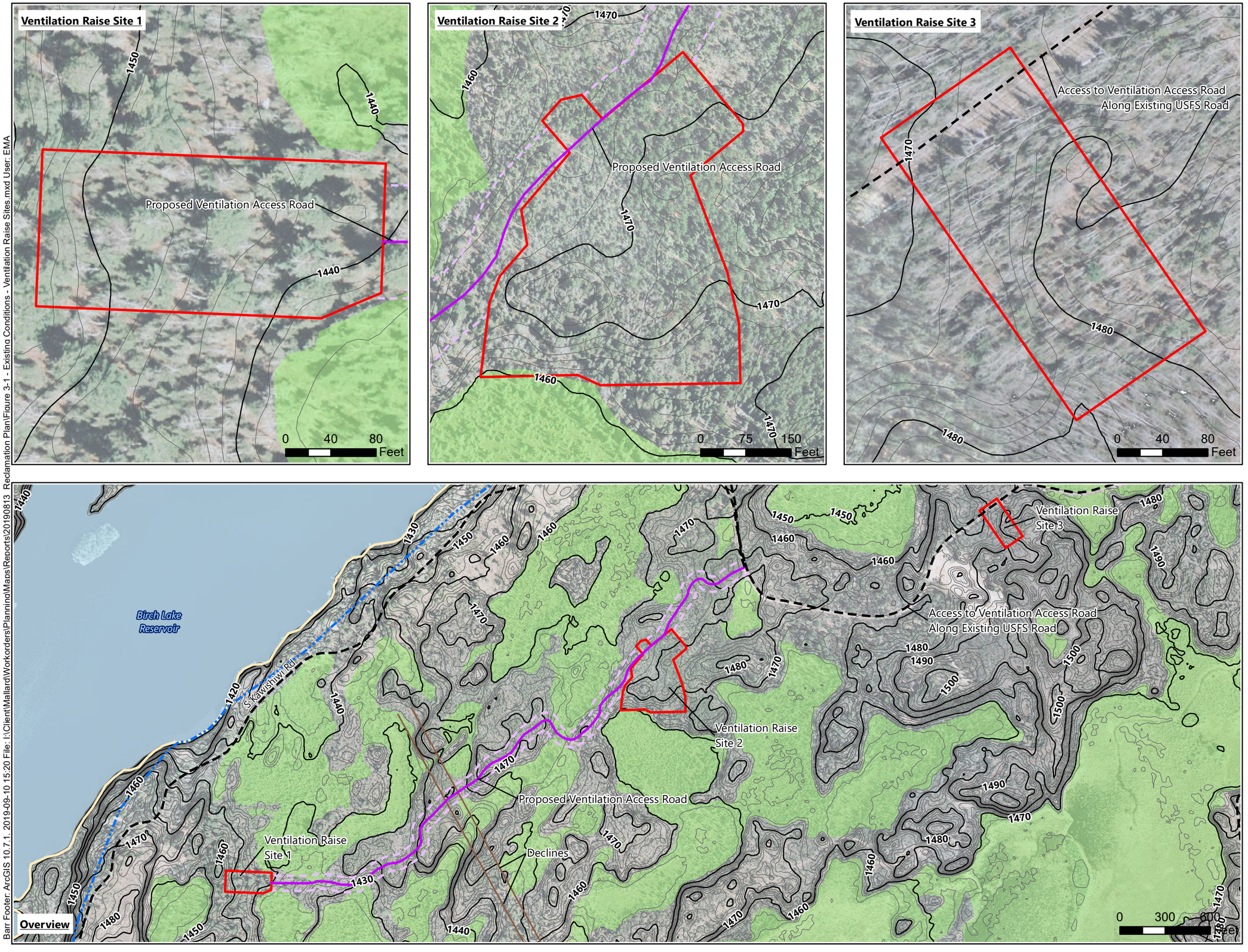


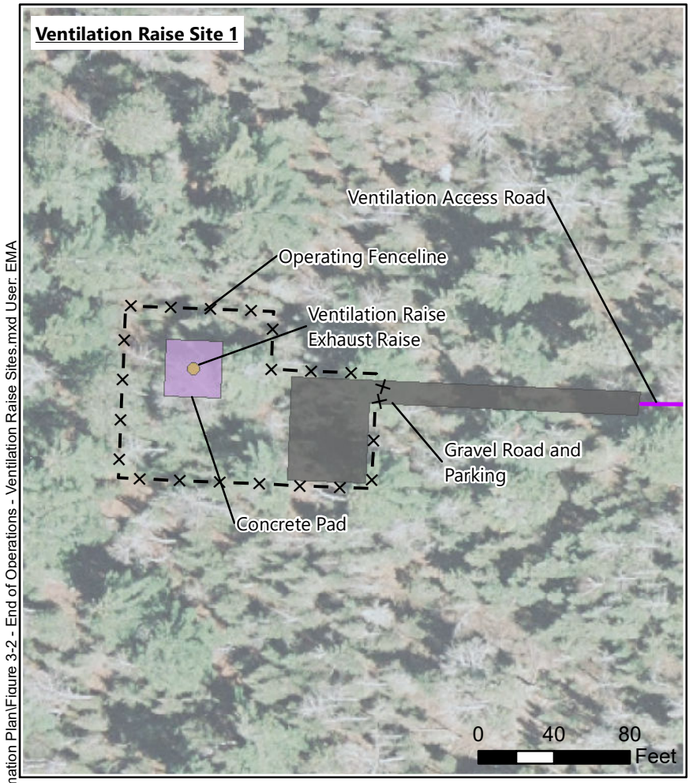
Figure 1-5
END OF OPERATIONS - TAILINGS MANAGEMENT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

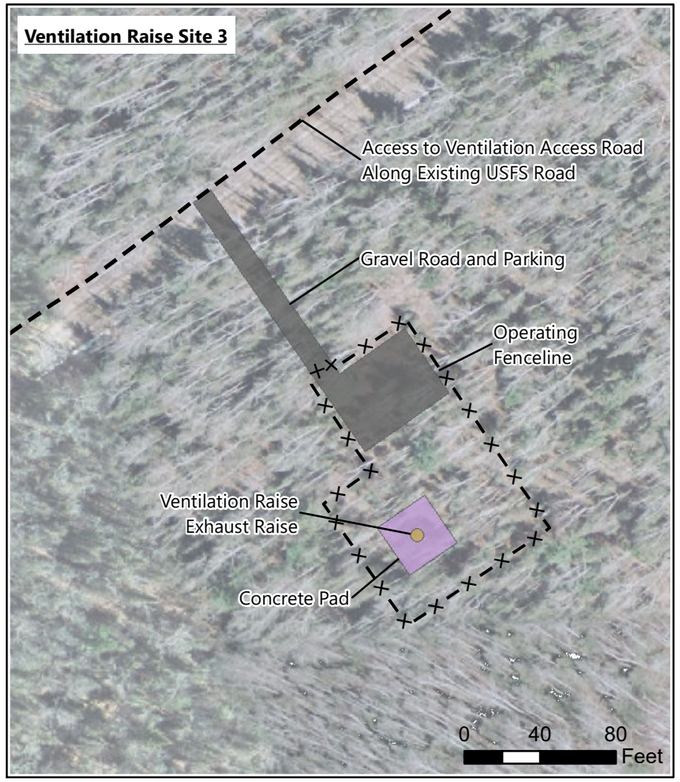
Barr Footer: ArcGIS 10.7.1, 2019-09-13 11:25 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 1-5 - End of Operations - Tailings Management Site.mxd User: EMA



Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:20 File: I:\Client\Mallard\Workorders\PlanningMaps\Reports\20190813_Reclamation Plan\Figure 3-1 - Existing Conditions - Ventilation Raise Sites.mxd User: EMA

Figure 3-1
EXISTING CONDITIONS -
VENTILATION RAISE SITES
Twin Metals Minnesota
Lake and St. Louis Counties, MN





Project Area

Underground Mine Area (Surface Projection)

Ventilation Raise Site

Ventilation Raise Access Road Corridor

Road

Declines

Fenceline

Building

Electrical/Power

Equipment/Infrastructure

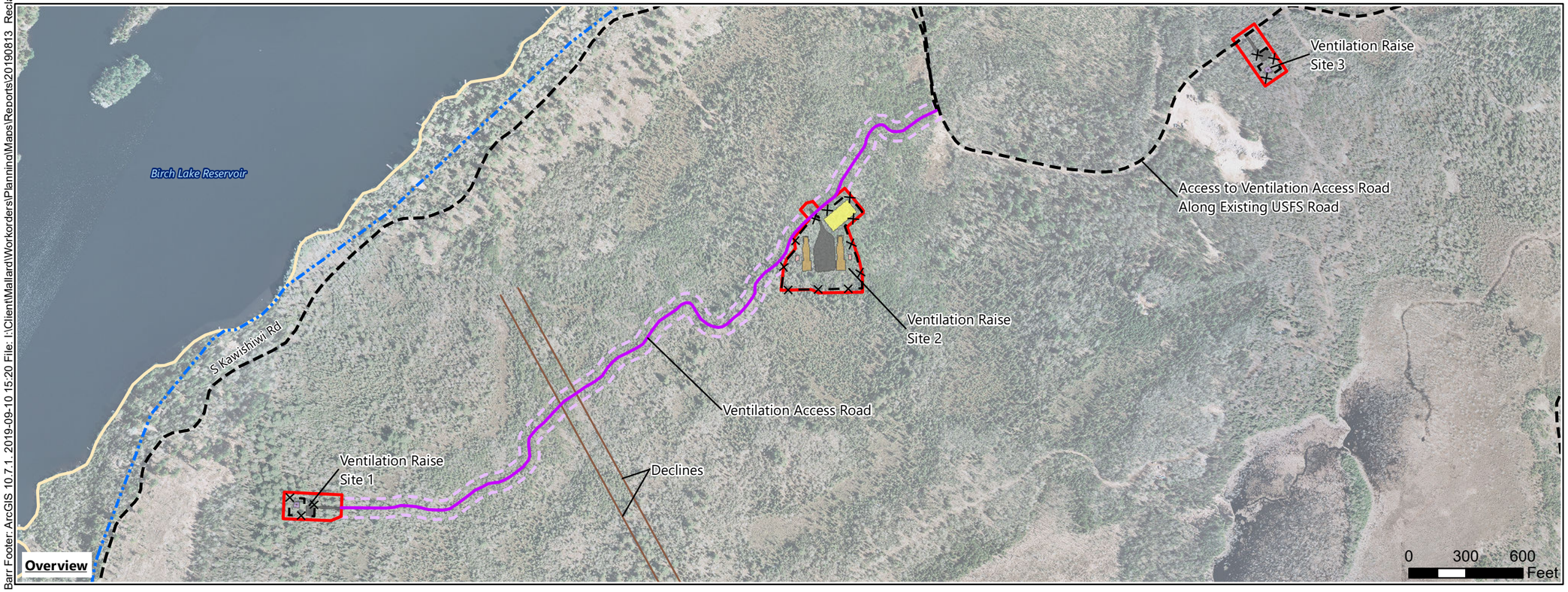
Fuel Storage

Laydown/Pad

Service Road/Parking

USFS Roads (2013)

Note: The underground mine area extent is roughly 3.9 miles long by 1.2 miles wide. The initial haulage tie-in point to the mine decline is approximately 1,170 feet below the portal collar elevation while the lowest stope centerline development is approximately 4,470 feet below the portal collar elevation.



N

Figure 3-2
END OF OPERATIONS -
VENTILATION RAISE SITES
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:20 File: I:\Client\Mallard\Workorders\PlanningMaps\Reports\20190813_Reclamation Plan\Figure 3-2 - End of Operations - Ventilation Raise Sites.mxd User: EMA

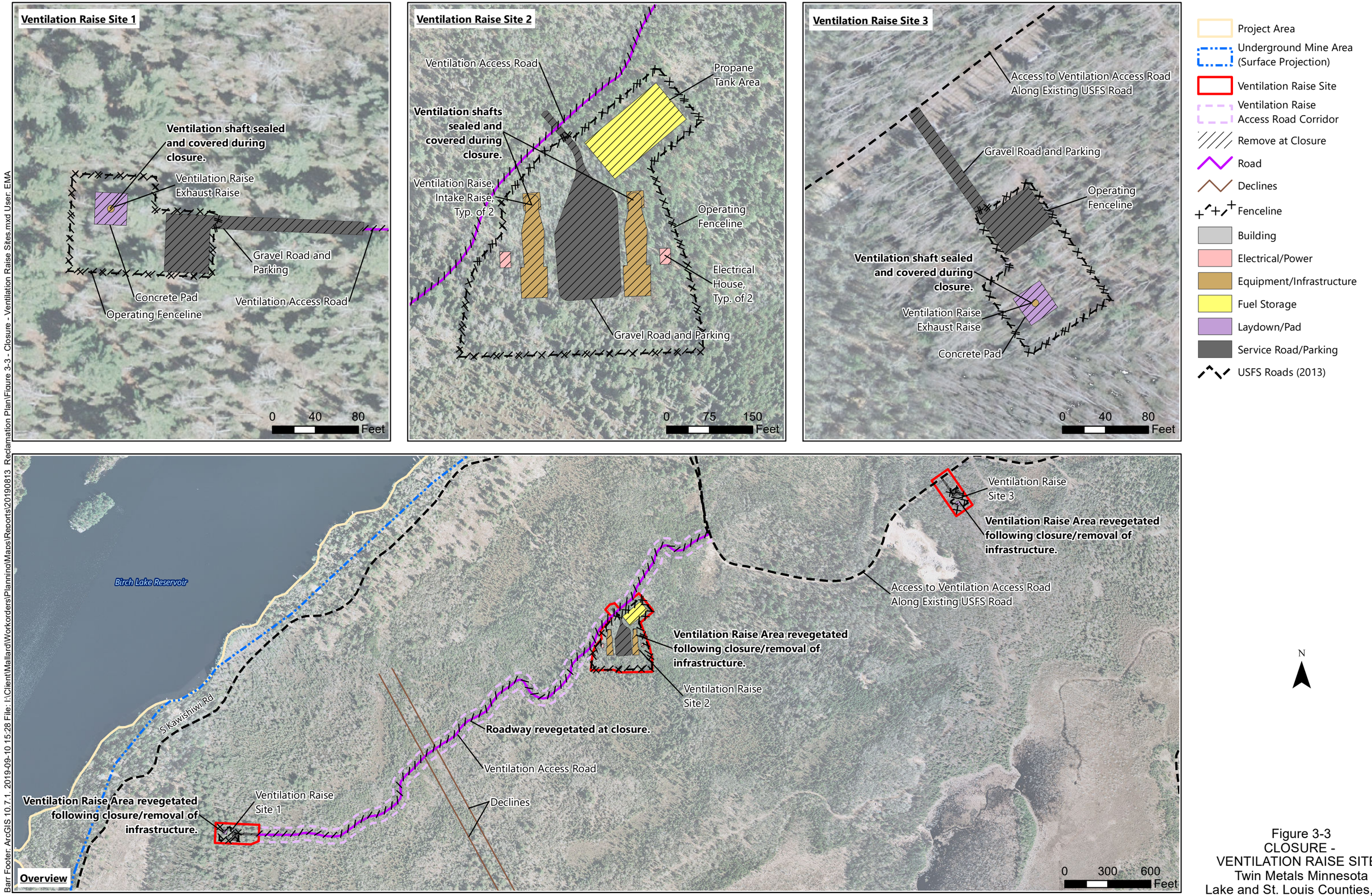


Figure 3-3
CLOSURE -
VENTILATION RAISE SITES
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1. 2019-09-10 15:28 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-3 - Closure - Ventilation Raise Sites.mxd User: EMA

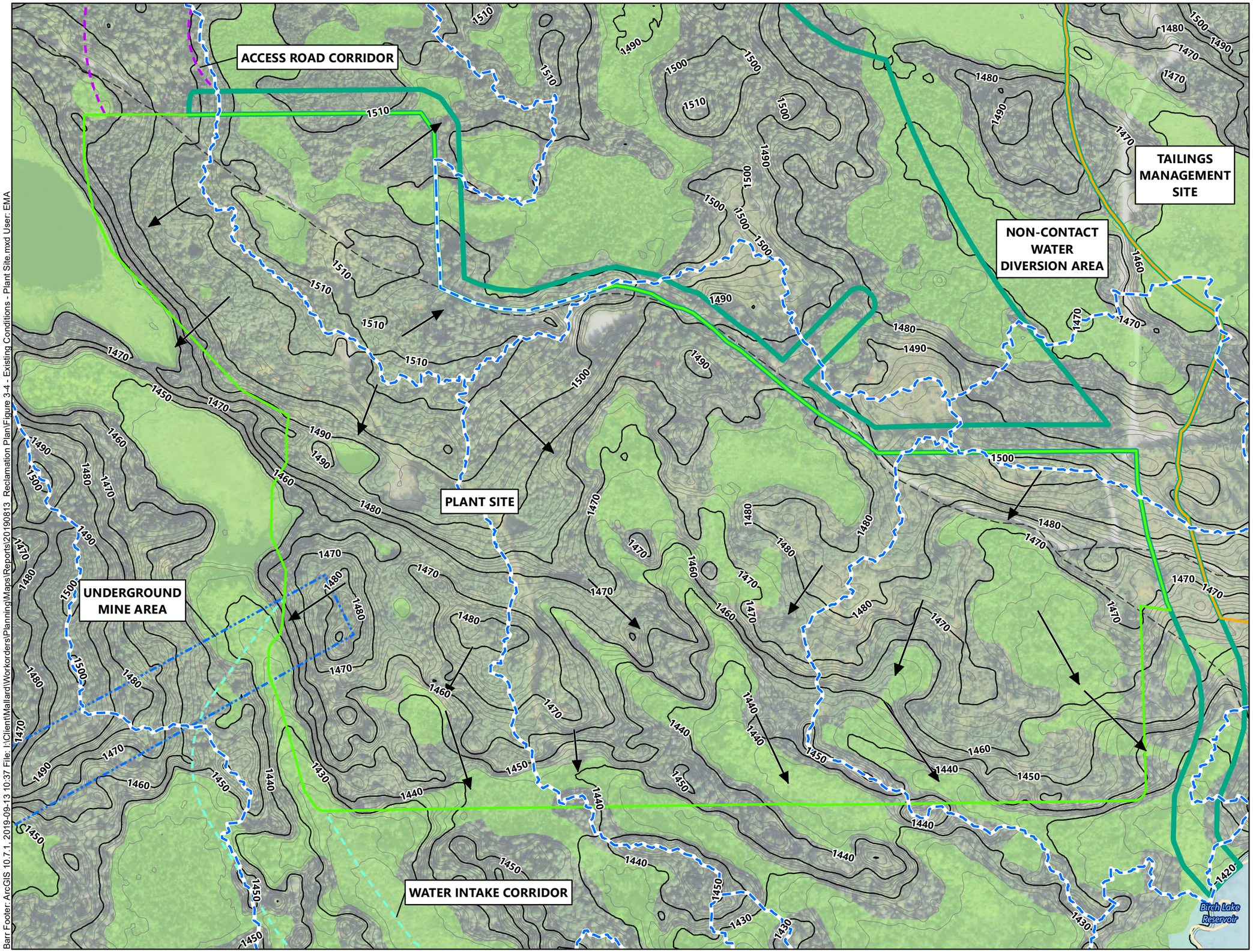


Figure 3-4
EXISTING CONDITIONS - PLANT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-13 10:37 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-4 - Existing Conditions - Plant Site.mxd User: EMA

ACCESS ROAD CORRIDOR
Access Road
Security/Guard Shack
Snow Storage
Reclamation Material Stockpile 1
NON-CONTACT WATER DIVERSION AREA
TAILINGS MANAGEMENT SITE
Waste Storage Area
Tire Wash
Parking
Propane Storage Tank
Bus Loop
Mine Services Building
Site Road
PLANT SITE
Overhead power-line from the off-site substation to plant site substation and from plant site substation to the TMS.
North Contact Water Pond
Snow Storage
Diesel Fuel
Reclamation Material Stockpile 2
Shotcrete Plant & Aggregate Stockpile
Engineered Tailings Backfill Pipeline
Substation
Propane Storage Tank
Ball Storage
Mine Water Tank
Portals
Coarse Ore Stockpile
Conveyor
Tailings Pipeline
Concentrator
UNDERGROUND MINE AREA
Sediment Pond
Service Building
Process Water Tank
Fresh Water and Fire Water Tank
Snow Storage
Access Decline
Conveyor Decline
Overflow Ore Stockpile
Process Water Pond
South Contact Water Pond
Storage
TRSF Lined Area and Ditches
Explosive Magazine
Central Contact Water Pond
Reagent Storage
Concentrator Services Building
Bus Loop/Parking
WATER INTAKE CORRIDOR
Water Intake Pipeline, Maintenance Access Road, Underground Power, and Communication
Birch Lake Reservoir

- Project Area
- Underground Mine Area (Surface Projection)
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Access Road Corridor
- Water Intake Corridor
- Road
- Transmission Line
- Equipment/Infrastructure
- Fenceline
- Water Intake Pipeline
- Project Contours
- Building
- Contact Water Pond
- Electrical/Power
- Equipment/Infrastructure
- Fuel Storage
- Laydown/Pad/Storage
- Reclamation Material Stockpile
- Service Road/Parking
- Stockpile
- Tailings Pipeline
- PWI Basin (MNDNR 2017)
- USFS Roads (2013)

N

0 175 350 700
Feet
0 50 100 200
Meters

Figure 3-5
END OF OPERATIONS - PLANT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1 2019-09-13 11:02 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-5 - End of Operations - Plant Site.mxd User: EMA

ACCESS ROAD CORRIDOR
Access Road
Security/Guard Shack
Snow Storage
Reclamation Material Stockpile 1
The closure approach for roads would be determined based on future land use plans. If roads are not needed to support future land use, they would be removed and reclaimed.
NON-CONTACT WATER DIVERSION AREA
TAILINGS MANAGEMENT SITE
Waste Storage Area
Parking
Tire Wash
Propane Storage Tank
Bus Loop
Mine Services Building
Site Road
PLANT SITE
Diesel Fuel
North Contact Water Pond
Snow Storage
Overhead power-line from the off-site substation to plant site substation and from plant site substation to the TMS.
Reclamation Material Stockpile 2
Shotcrete Plant & Aggregate Stockpile
Engineered Tailings Backfill Pipeline
Substation
Propane Storage Tank
Ball Storage
Mine Water Tank
Portals
Coarse Ore Stockpile
Conveyor
Tailings Pipeline
Concentrator
UNDERGROUND MINE AREA
Sediment Pond
Service Building
Process Water Tank
Fresh Water and Fire Water Tank
Snow Storage
Overflow Ore Stockpile
Process Water Pond
South Contact Water Pond
Storage
Access Decline
Conveyor Decline
TRSF Lined Area and Ditches
Explosive Magazine
Central Contact Water Pond
Reagent Storage
Concentrator Services Building
Bus Loop/Parking
WATER INTAKE CORRIDOR
Water Intake Pipeline, Maintenance Access Road, Underground Power, and Communication
Birch Lake Reservoir

- Project Area
- Underground Mine Area (Surface Projection)
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Access Road Corridor
- Water Intake Corridor
- Remove at Closure
- To Be Determined Based on Future Land Use
- Road
- Transmission Line
- Equipment/Infrastructure
- Fenceline
- Water Intake Pipeline
- Project Contours
- Building
- Contact Water Pond
- Electrical/Power
- Equipment/Infrastructure
- Fuel Storage
- Laydown/Pad/Storage
- Reclamation Material Stockpile
- Service Road/Parking
- Stockpile
- Tailings Pipeline
- PWI Basin (MNDNR 2017)
- USFS Roads (2013)

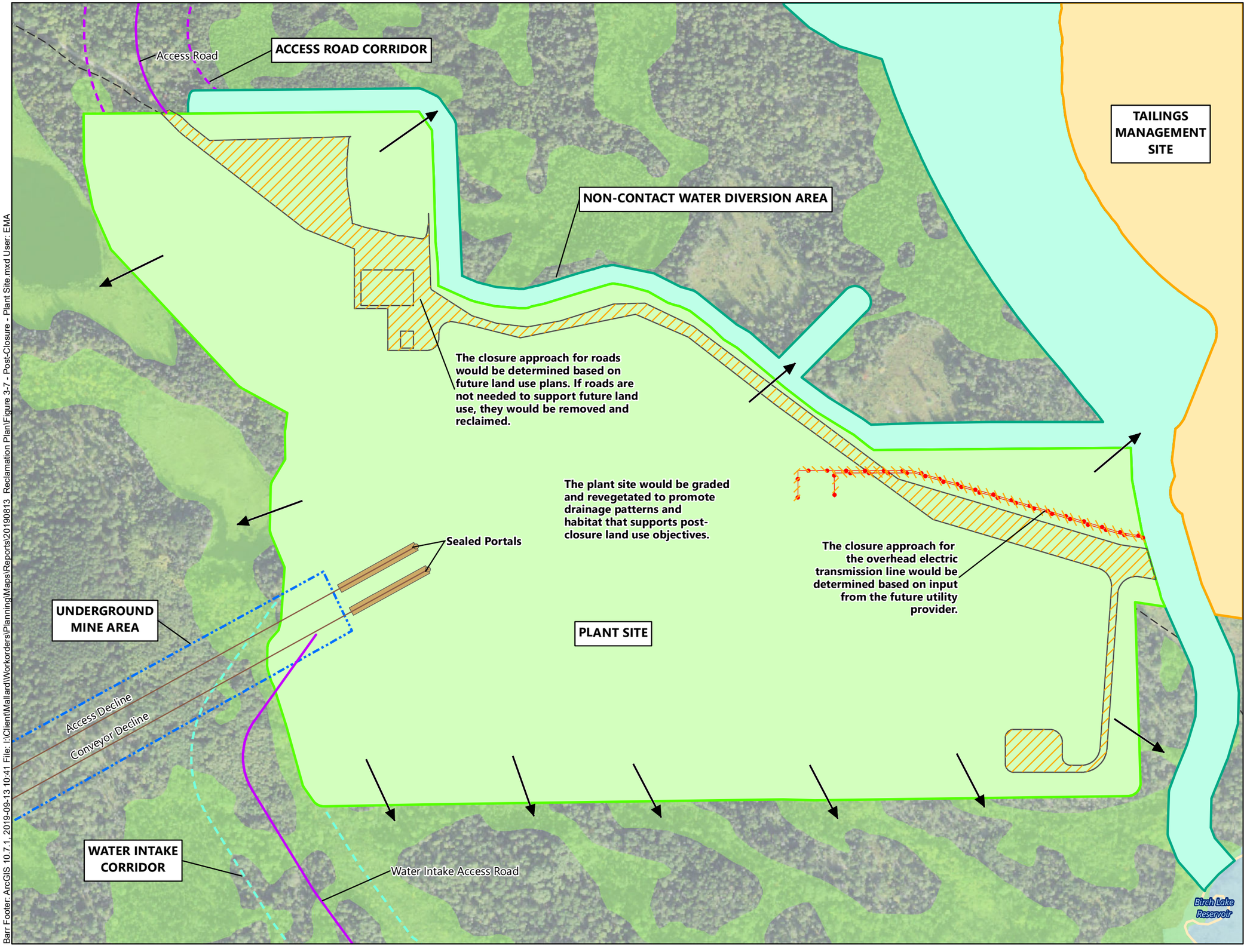
N

0 175 350 700
Feet

0 50 100 200
Meters

Figure 3-6
CLOSURE - PLANT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1 2019-09-13 11:14 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-6 - Closure - Plant Site.mxd User: EMA



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Road
Transmission Line
Equipment/Infrastructure
To Be Determined Based on Future Land Use
Equipment/Infrastructure
Service Road/Parking
Approximate Runoff Flow Direction Following Closure
Wetlands
PWI Basin (MNDNR 2017)
USFS Roads (2013)

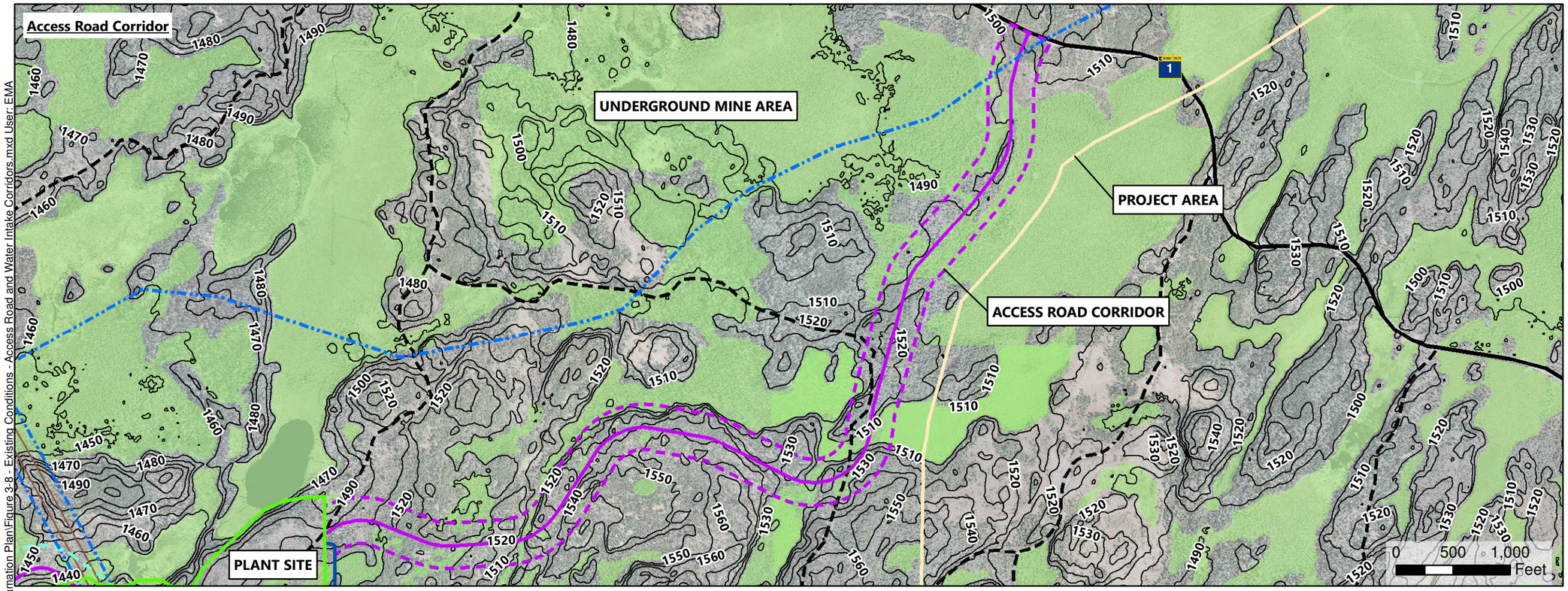
N

0 175 350 700
Feet

0 50 100 200
Meters

Figure 3-7
POST-CLOSURE - PLANT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-13 10:41 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-7 - Post-Closure - Plant Site.mxd User: EMA

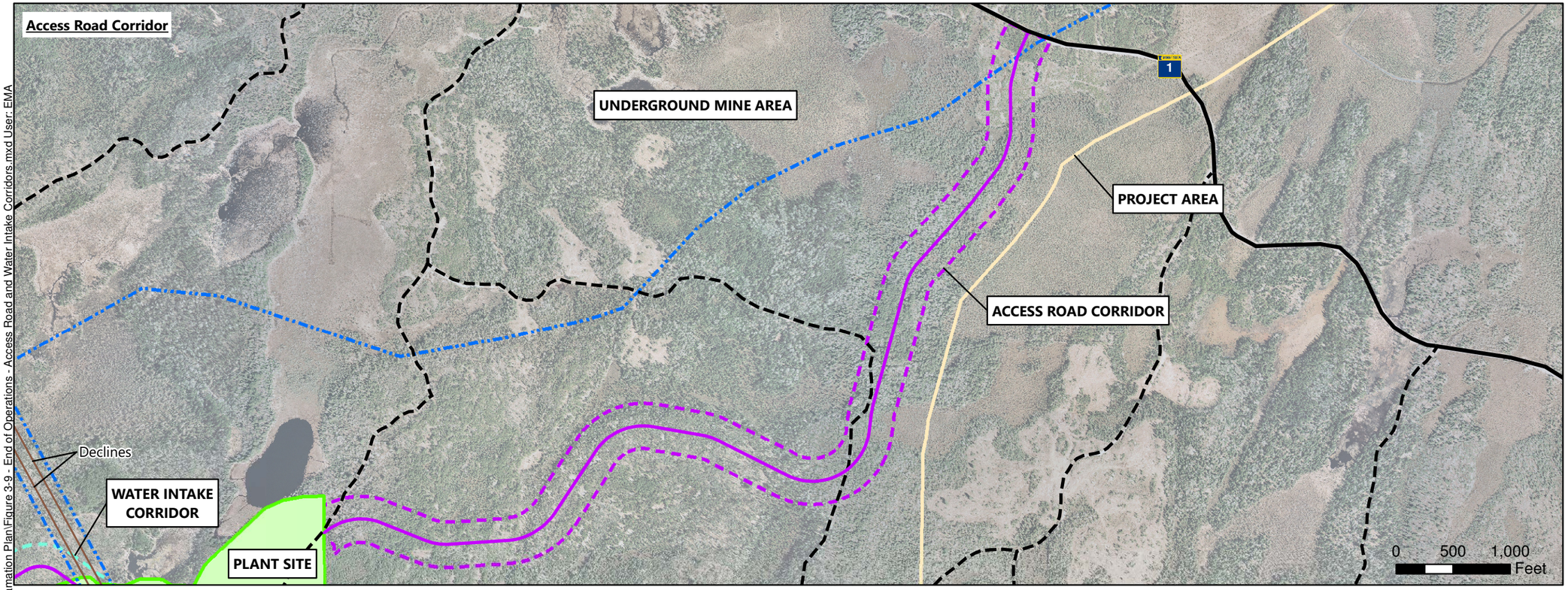


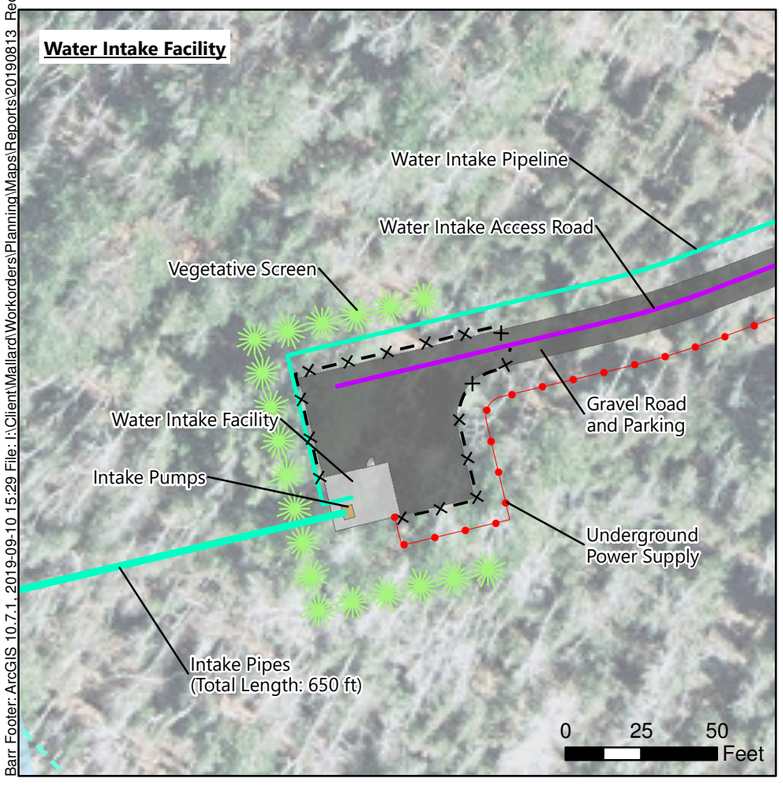
Note: Proposed Project footprints are shown relative to existing site conditions for context.

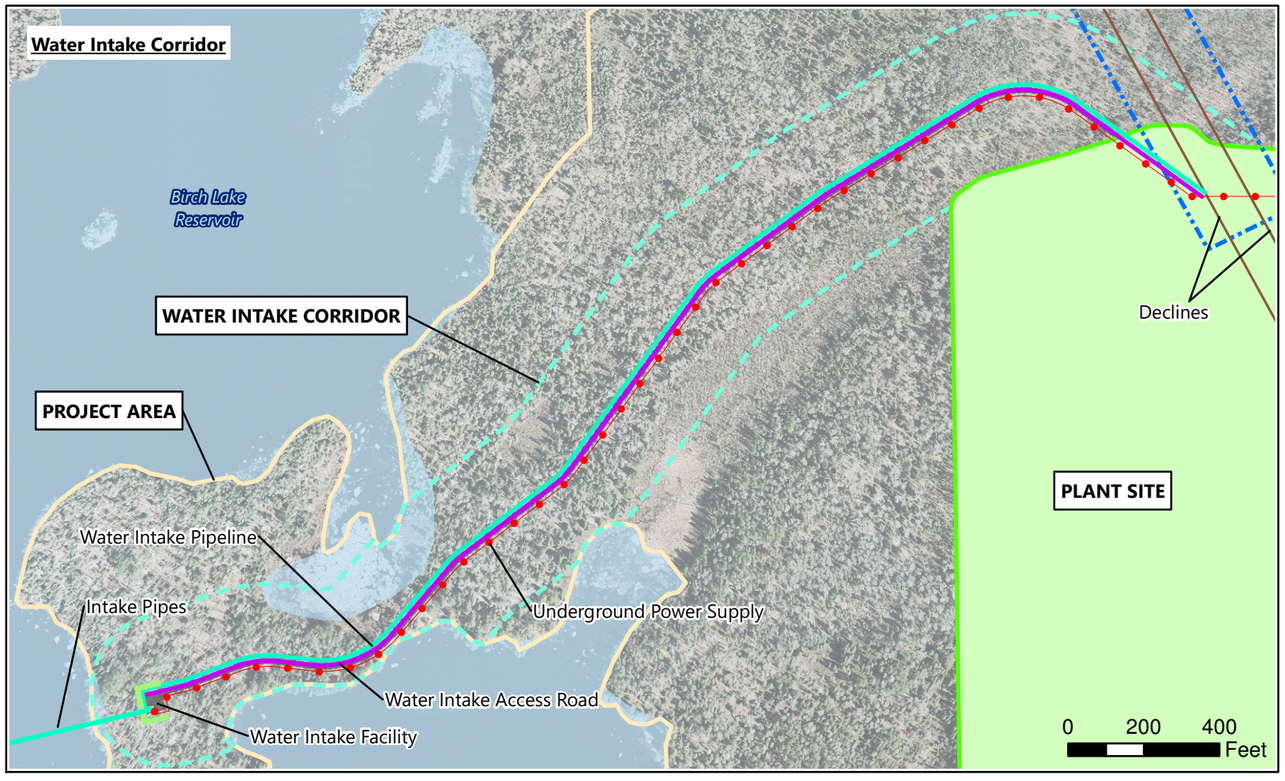
Figure 3-8
EXISTING CONDITIONS - ACCESS ROAD & WATER INTAKE CORRIDORS
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:29 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-8 - Existing Conditions - Access Road and Water Intake Corridors.mxd User: EMA

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:29 File: J:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-9 - End of Operations - Access Road and Water Intake Corridors.mxd User: EMA







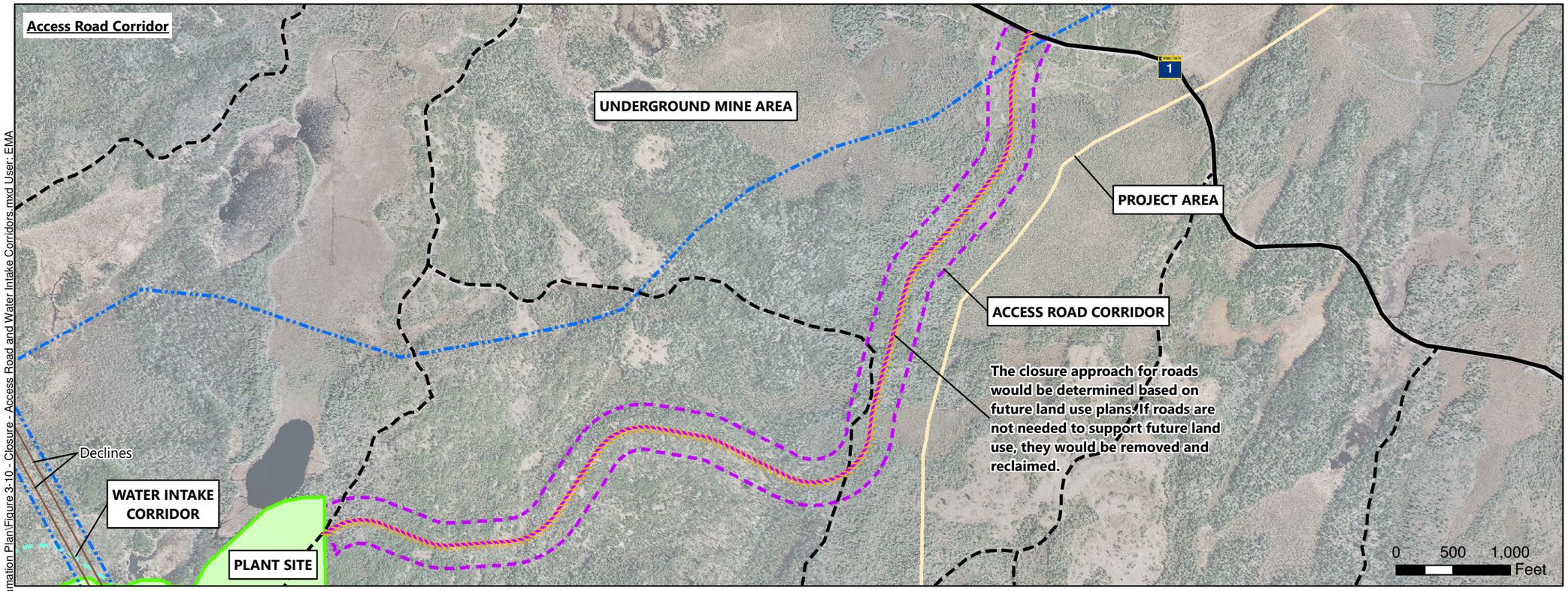
- Project Area
- Underground Mine Area (Surface Projection)
- Plant Site
- Access Road Corridor
- Water Intake Corridor
- Road
- Declines
- Water Intake Pipeline
- Vegetative Screen
- Transmission Line
- Fenceline
- Building
- Equipment/Infrastructure
- Service Road/Parking
- PWI Basin (MNDNR 2017)
- USFS Roads (2013)

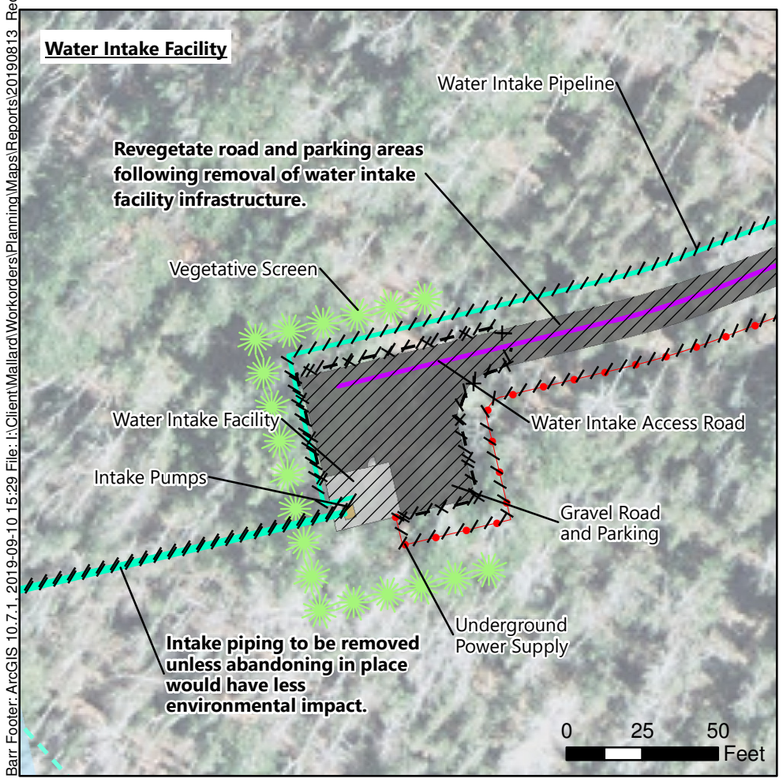
Streets and Highways (MnDOT)

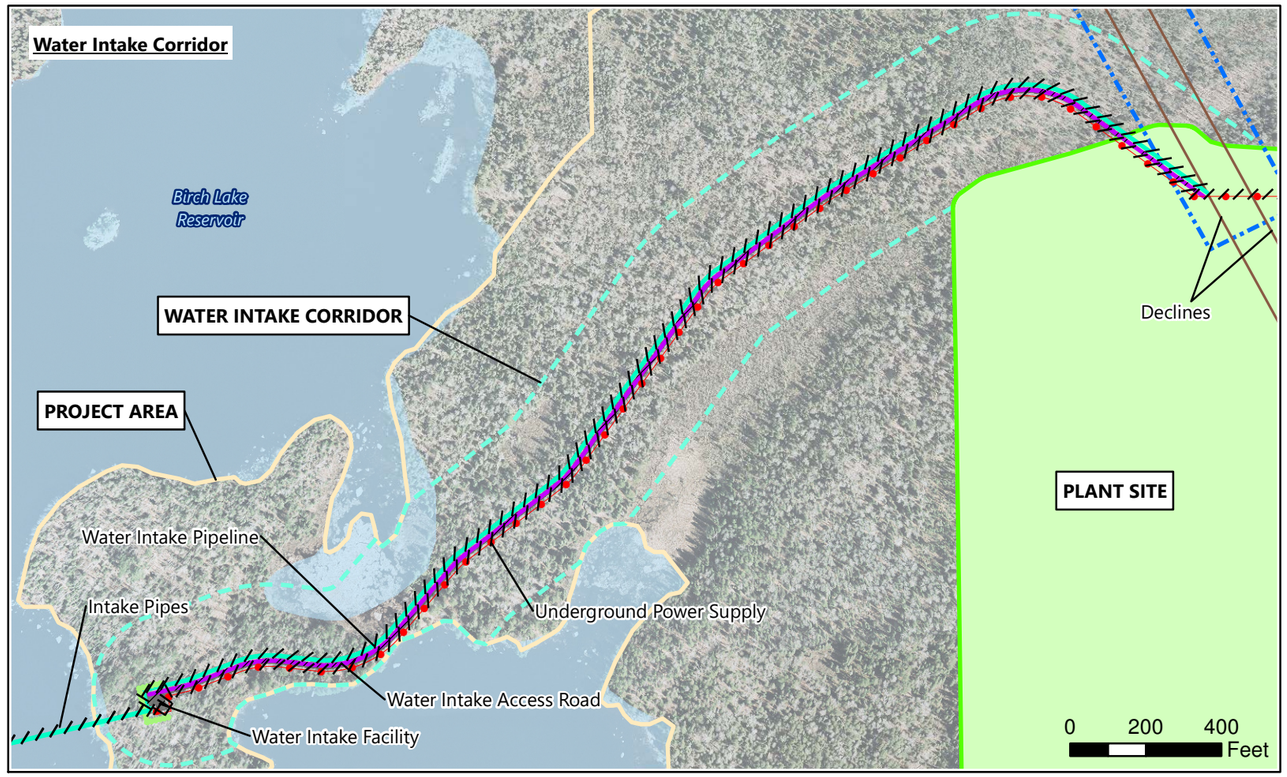
- State Trunk Highway

N

Figure 3-9
END OF OPERATIONS - ACCESS ROAD & WATER INTAKE CORRIDORS
Twin Metals Minnesota
Lake and St. Louis Counties, MN







Project Area
Underground Mine Area (Surface Projection)
Plant Site
Access Road Corridor
Water Intake Corridor
Remove at Closure
To Be Determined Based on Future Land Use
Road
Declines
Water Intake Pipeline
Vegetative Screen
Transmission Line
Fenceline
Building
Equipment/Infrastructure
Service Road/Parking
PWI Basin (MNDNR 2017)
USFS Roads (2013)
Streets and Highways (MnDOT)
State Trunk Highway

N

Figure 3-10
CLOSURE -
ACCESS ROAD & WATER
INTAKE CORRIDORS
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:29 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-10 - Closure - Access Road and Water Intake Corridors.mxd User: EMA

Barr Footer: ArcGIS 10.7.1 2019-09-10 15:34 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-11 - Existing Conditions - Transmission Corridor.mxd User: EMA

TAILINGS MANAGEMENT SITE

TRANSMISSION CORRIDOR

PROJECT STUDY AREA

Off-Site Electrical Substation

Kangas Lake

Kangas Creek

Birch Lake Reservoir

Dunka Pit

Unnamed Stream

Dunka River

Keeley Creek

Denley Creek

Stony River

Unnamed Creek

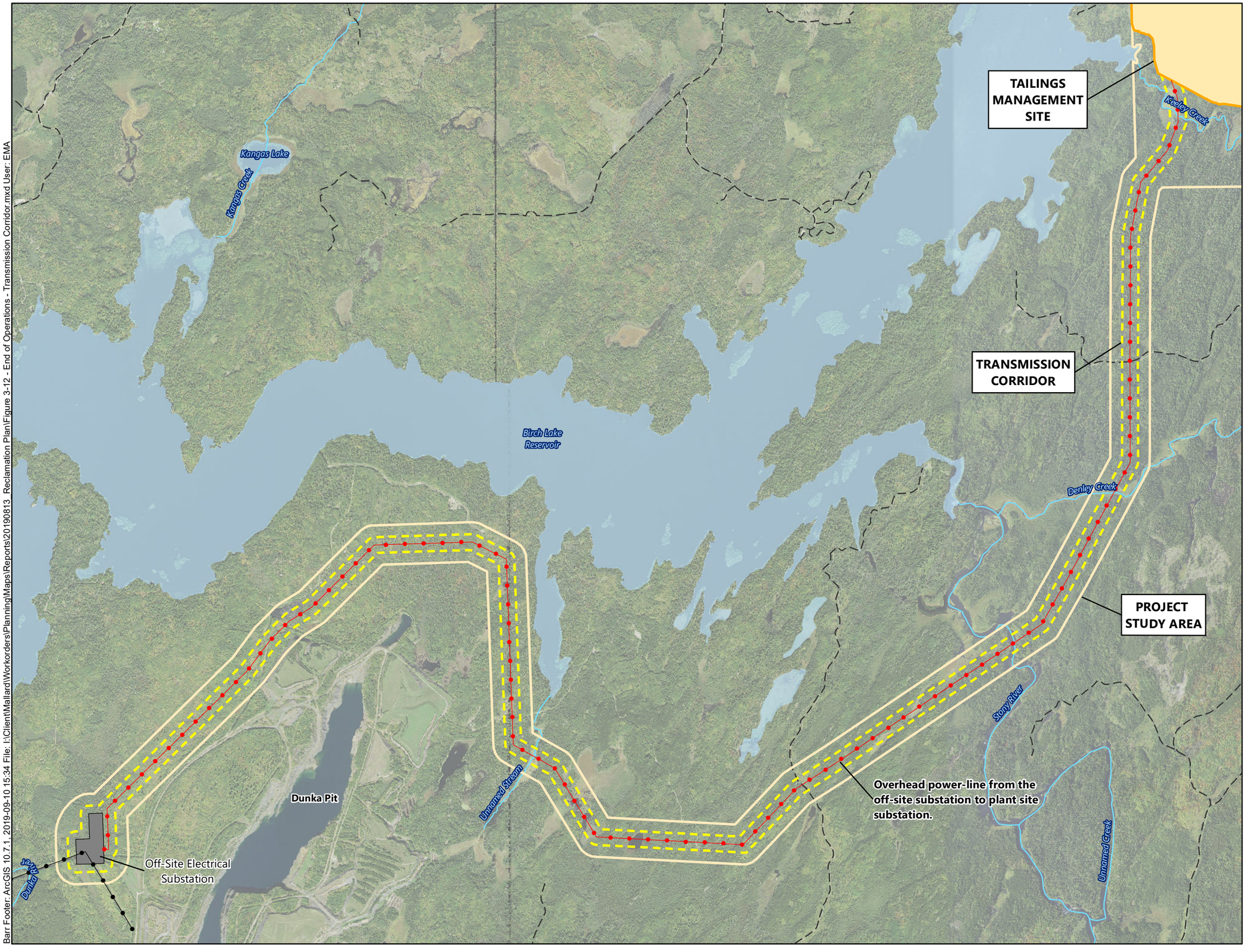
- Project Area
- Tailings Management Site
- Transmission Corridor
- Electric Substation
- PWI Watercourse (MNDNR 2017)
- PWI Basin (MNDNR 2017)
- Wetlands
- Existing 10 ft Contour (3.0 meters)
- USFS Roads (2013)

N

0 1,000 2,000 4,000
Feet

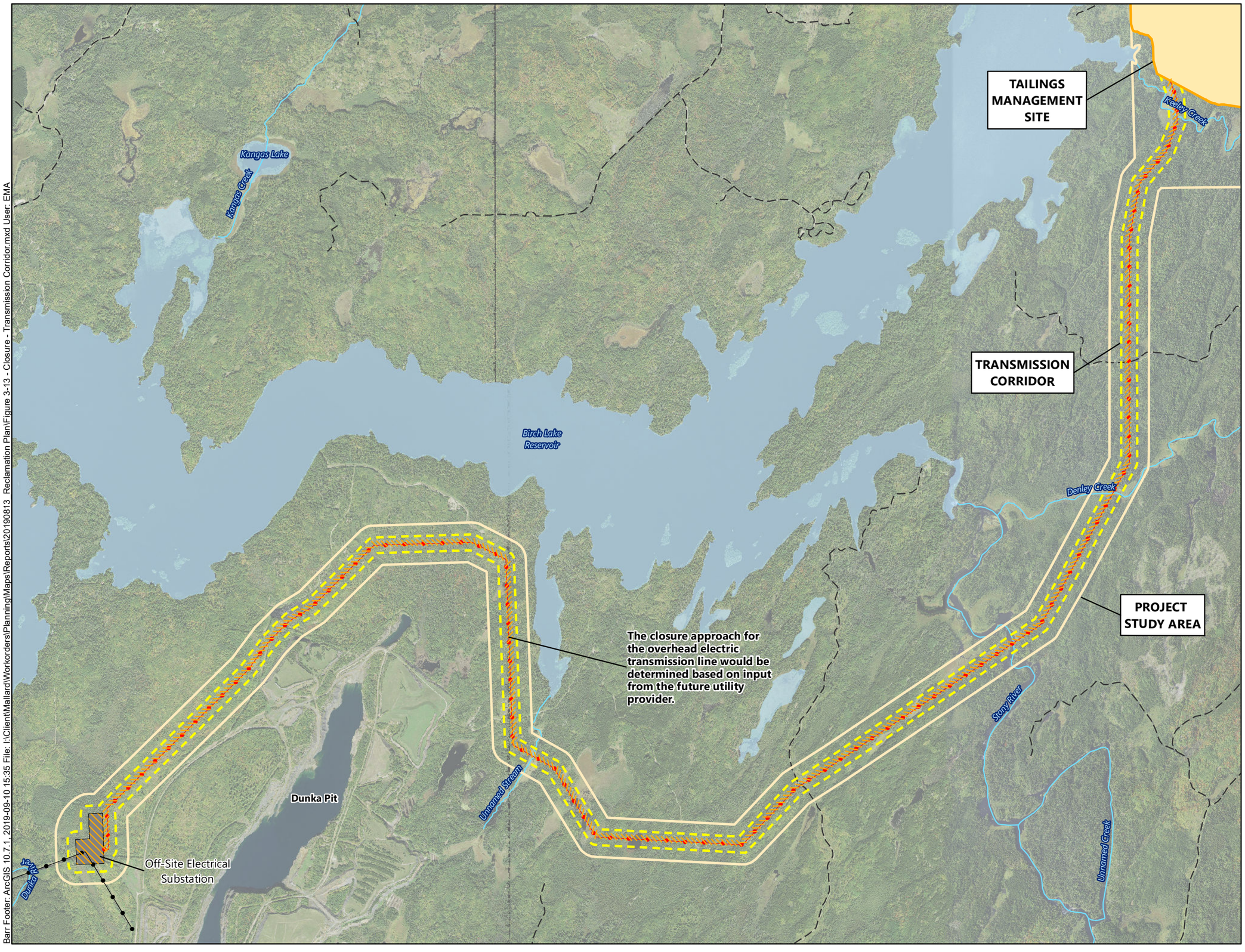
0 250 500 1,000
Meters

Figure 3-11
EXISTING CONDITIONS - TRANSMISSION CORRIDOR
Twin Metals Minnesota
Lake and St. Louis Counties, MN



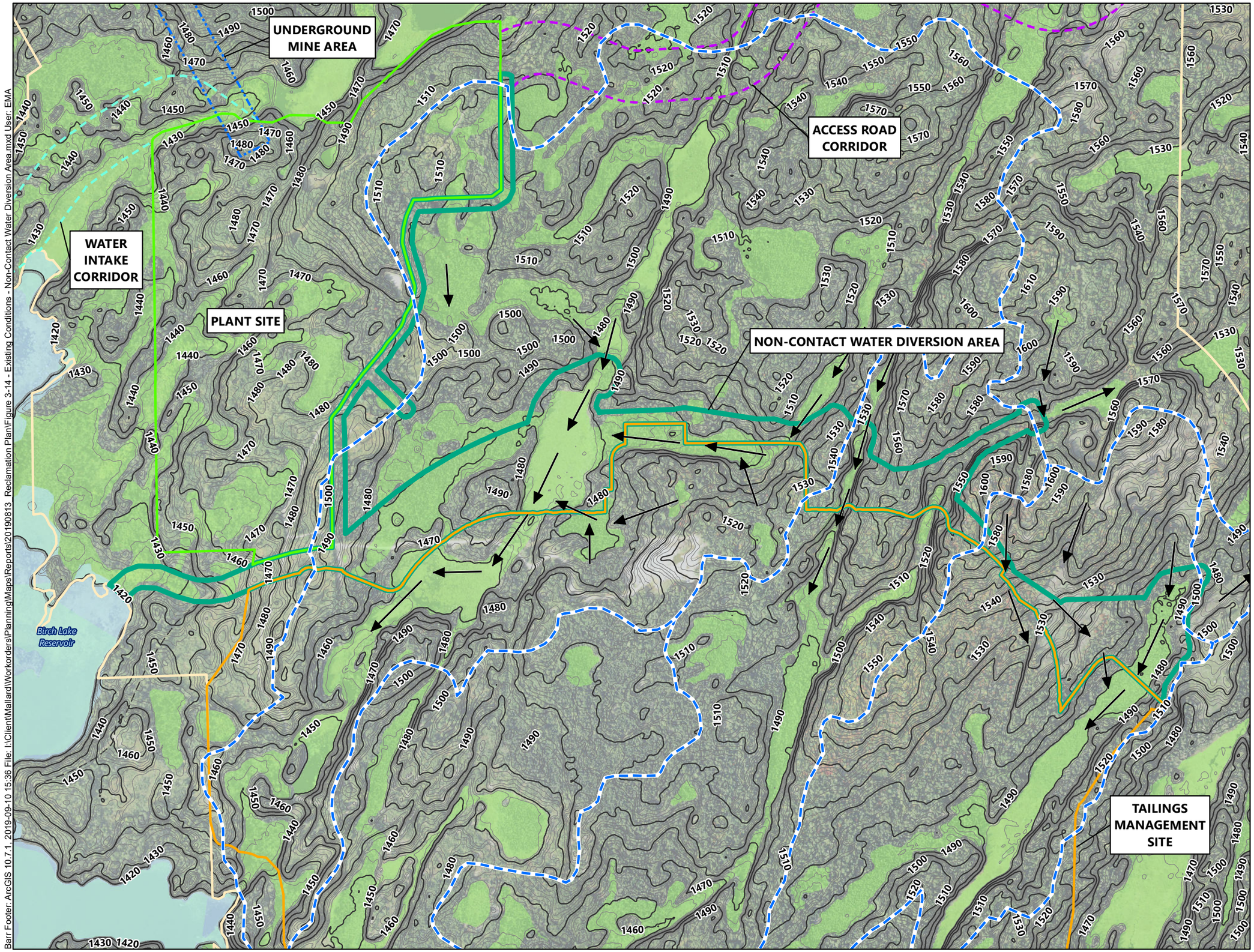
Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:34 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-12 - End of Operations - Transmission Corridor.mxd User: EMA

Figure 3-12
END OF OPERATIONS -
TRANSMISSION CORRIDOR
Twin Metals Minnesota
Lake and St. Louis Counties, MN



Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:35 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-13 - Closure - Transmission Corridor.mxd User: EMA

Figure 3-13
CLOSURE -
TRANSMISSION CORRIDOR
Twin Metals Minnesota
Lake and St. Louis Counties, MN



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Approximate Existing Watershed Divides
Approximate Existing Runoff Flow Direction
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
Wetlands
Existing 10 ft Contour (3.0 meters)
Existing 2 ft Contour (0.61 meters)
USFS Roads (2013)

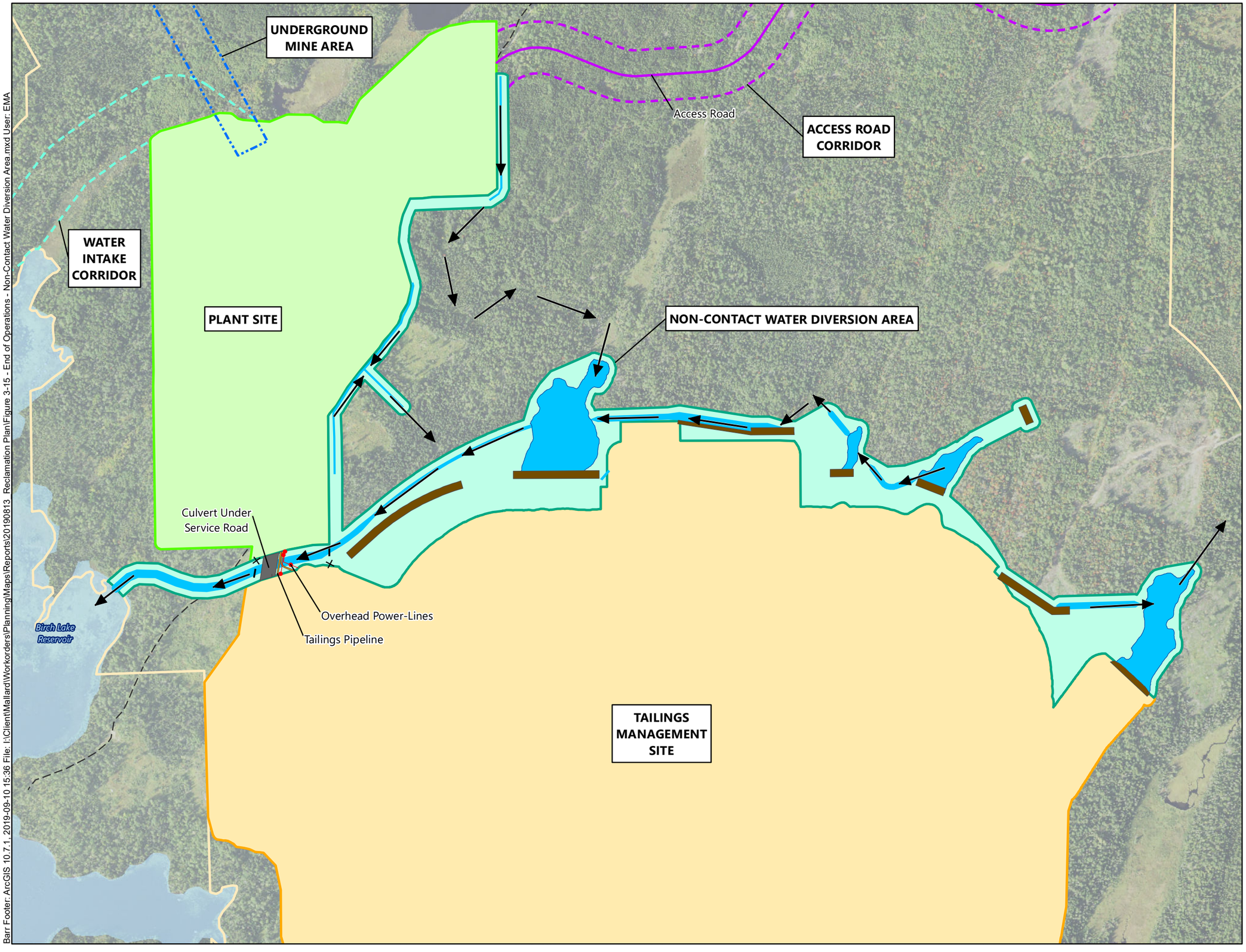
N

0 350 700 1,400
Feet

0 100 200 400
Meters

Figure 3-14
EXISTING CONDITIONS - NON-CONTACT WATER DIVERSION AREA
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:36 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-14 - Existing Conditions - Non-Contact Water Diversion Area.mxd User: EMA



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Road
Transmission Line
Fenceline
Dike
Non-Contact Water Ditch (NWD)
Non-Contact Water Pond (NWP)
Service Road/Parking
Tailings Pipeline
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
Approximate Flow Direction
USFS Roads (2013)

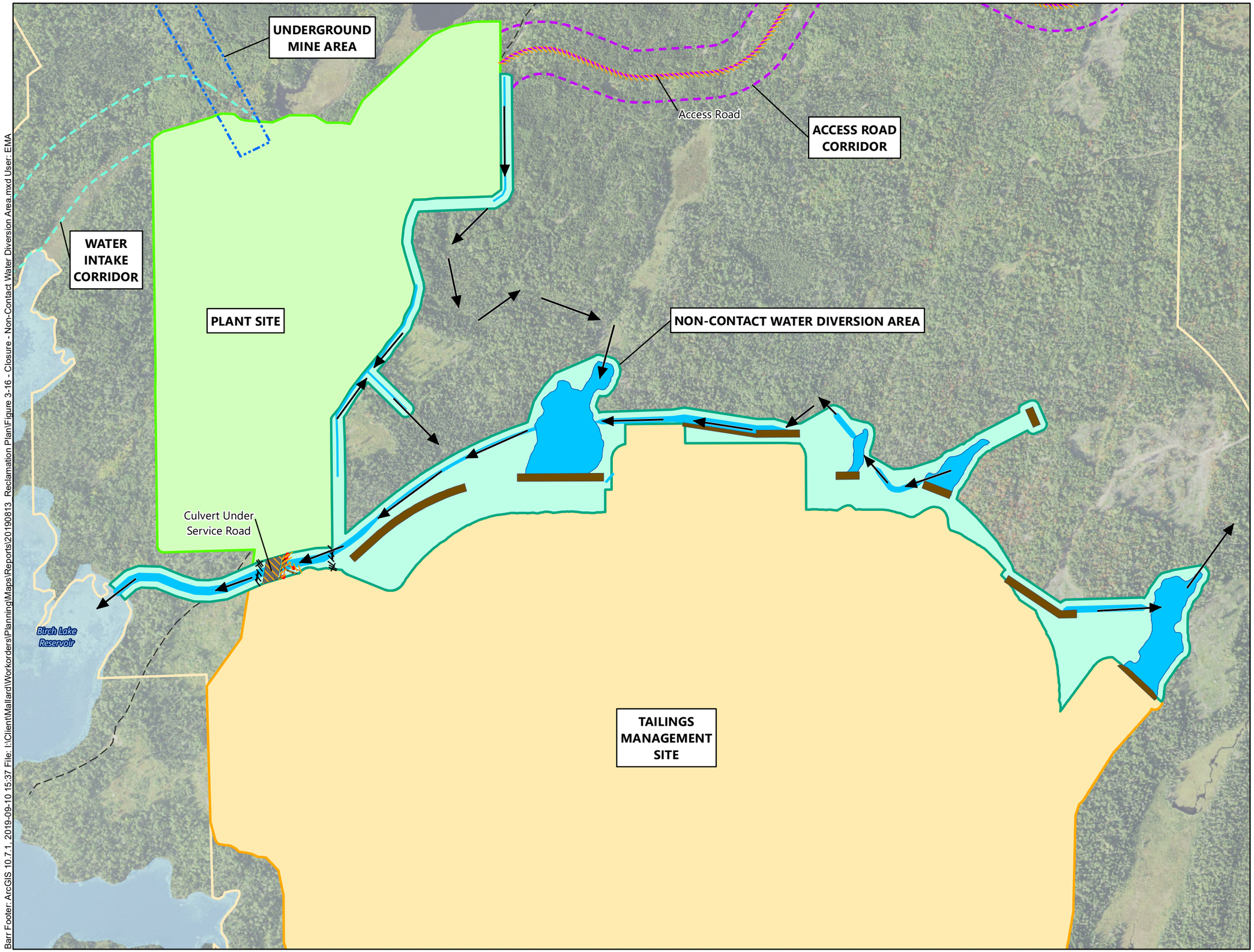
N

0 350 700 1,400
Feet

0 100 200 400
Meters

Figure 3-15
END OF OPERATIONS - NON-CONTACT WATER DIVERSION AREA
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1 2019-09-10 15:36 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-15 - End of Operations - Non-Contact Water Diversion Area.mxd User: EMA



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Water Intake Corridor
Remove at Closure
To Be Determined Based on Future Land Use
Road
Transmission Line
Fenceline
Dike
Non-Contact Water Ditch (NWD)
Non-Contact Water Pond (NWP)
Service Road/Parking
Tailings Pipeline
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
Approximate Flow Direction
USFS Roads (2013)

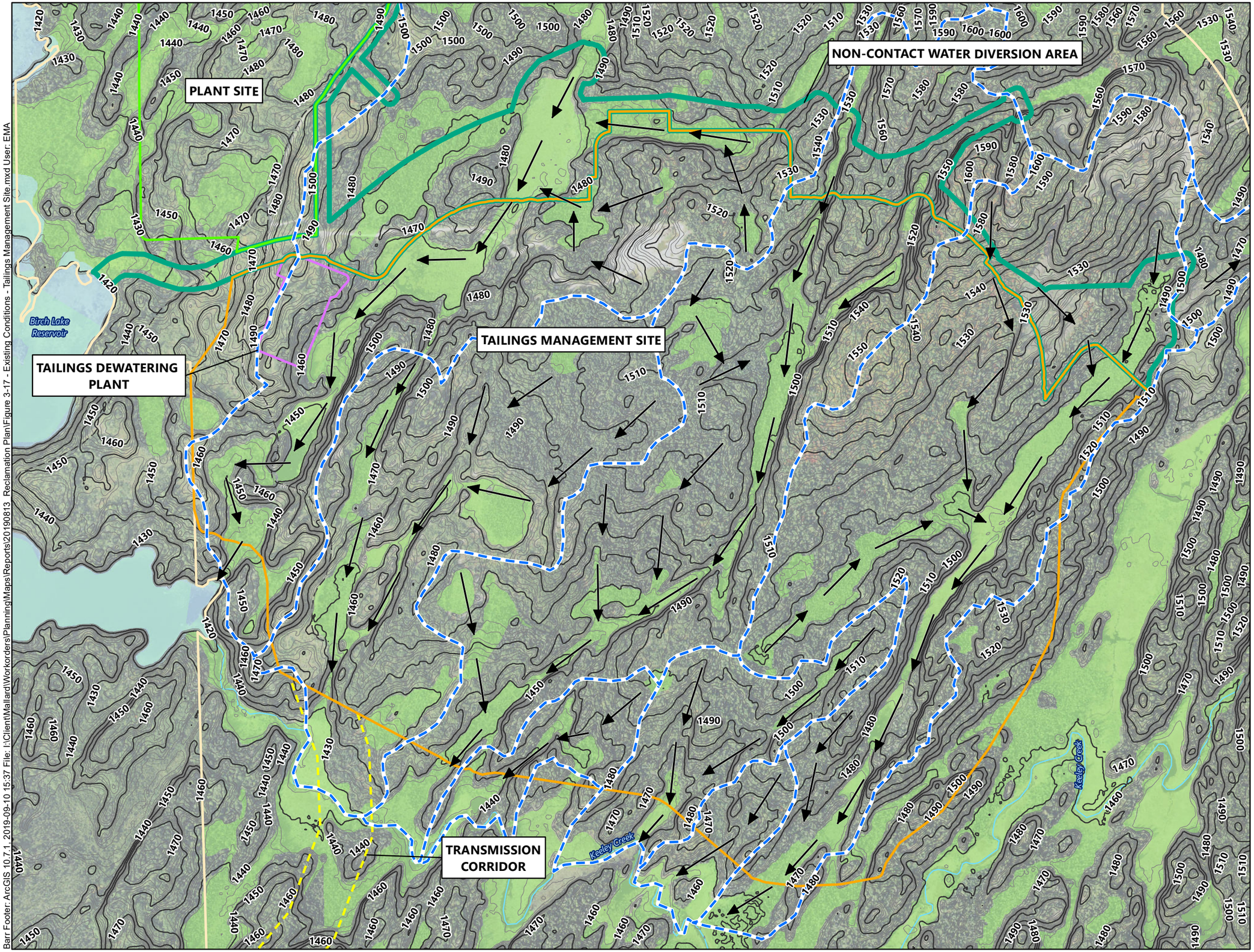
N

0 350 700 1,400
Feet

0 100 200 400
Meters

Figure 3-16
CLOSURE -
NON-CONTACT WATER
DIVERSION AREA
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:37 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-16 - Closure - Non-Contact Water Diversion Area.mxd User: EMA



Project Area
Plant Site
Tailings Management Site
Tailings Dewatering Plant
Non-Contact Water Diversion Area
Transmission Corridor
Approximate Existing Watershed Divides
Approximate Existing Runoff Flow Direction
PWI Watercourse (MNDNR 2017)
PWI Basin (MNDNR 2017)
Wetlands
Existing 10 ft Contour (3.0 meters)
Existing 2 ft Contour (0.61 meters)
USFS Roads (2013)

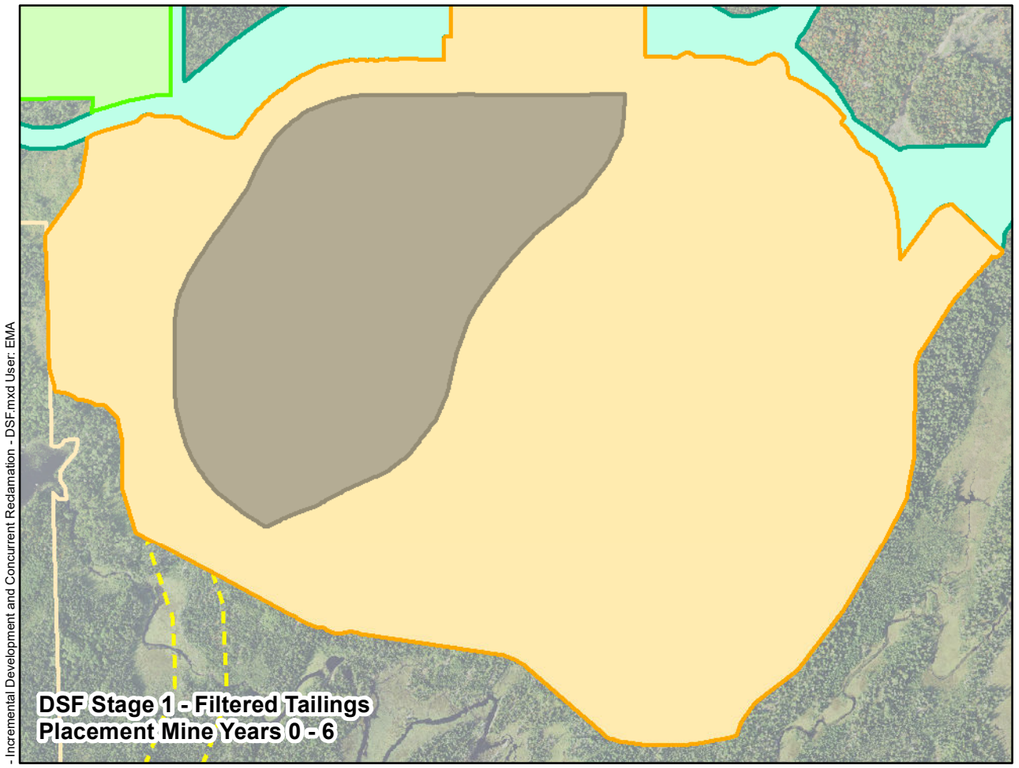
N

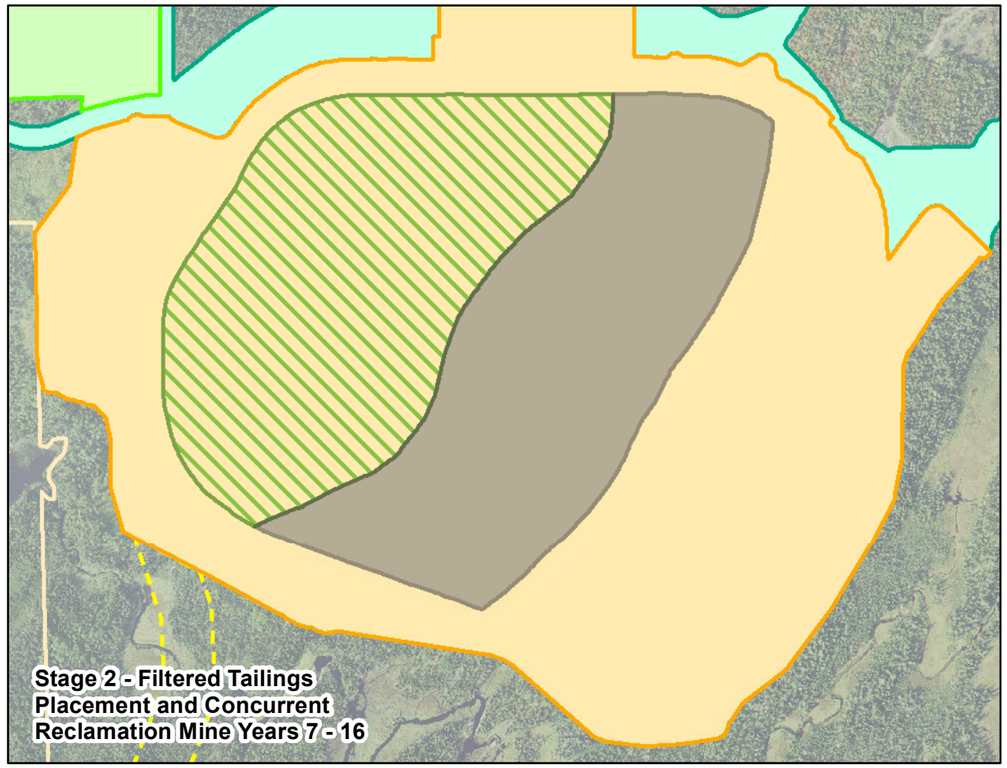
0 350 700 1,400
Feet

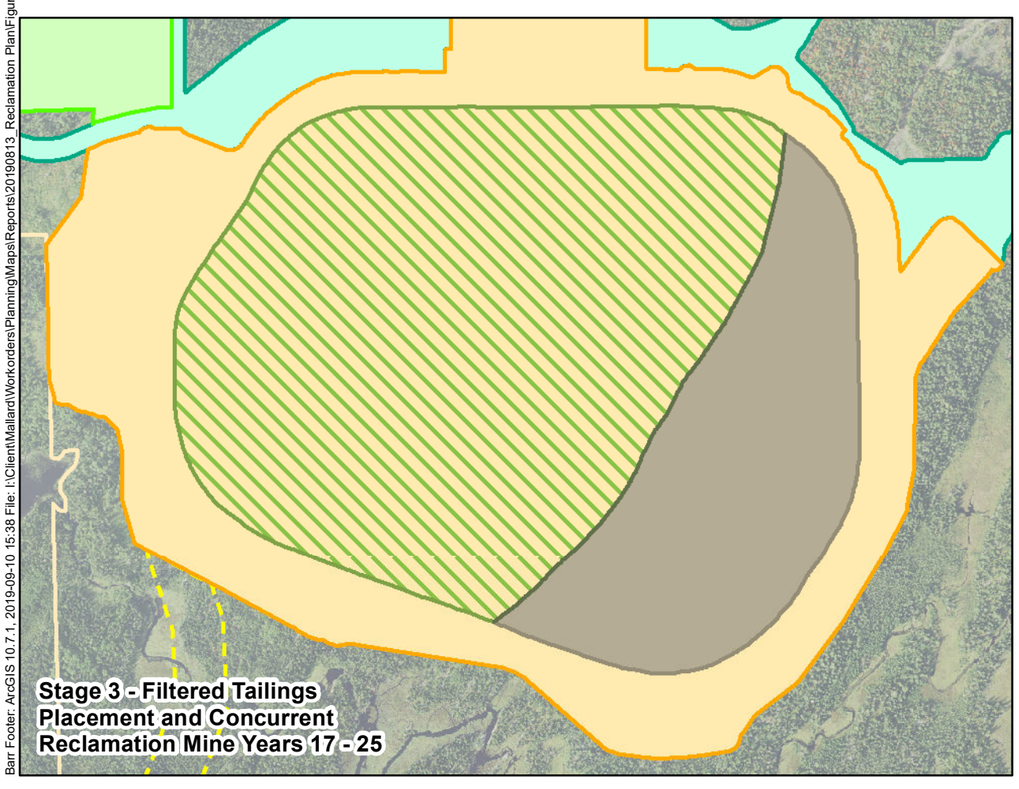
0 100 200 400
Meters

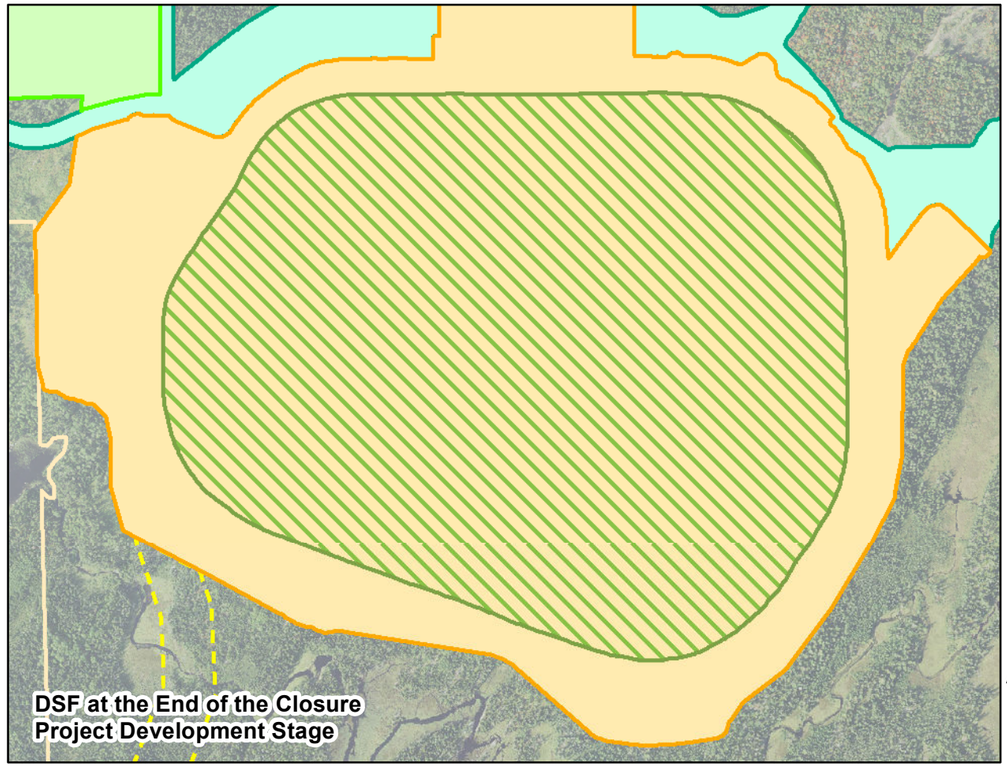
Figure 3-17
EXISTING CONDITIONS - TAILINGS MANAGEMENT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:37 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-17 - Existing Conditions - Tailings Management Site.mxd User: EMA









Project Area
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Transmission Corridor
DSF Footprint Development
Approximate Reclaimed DSF Area

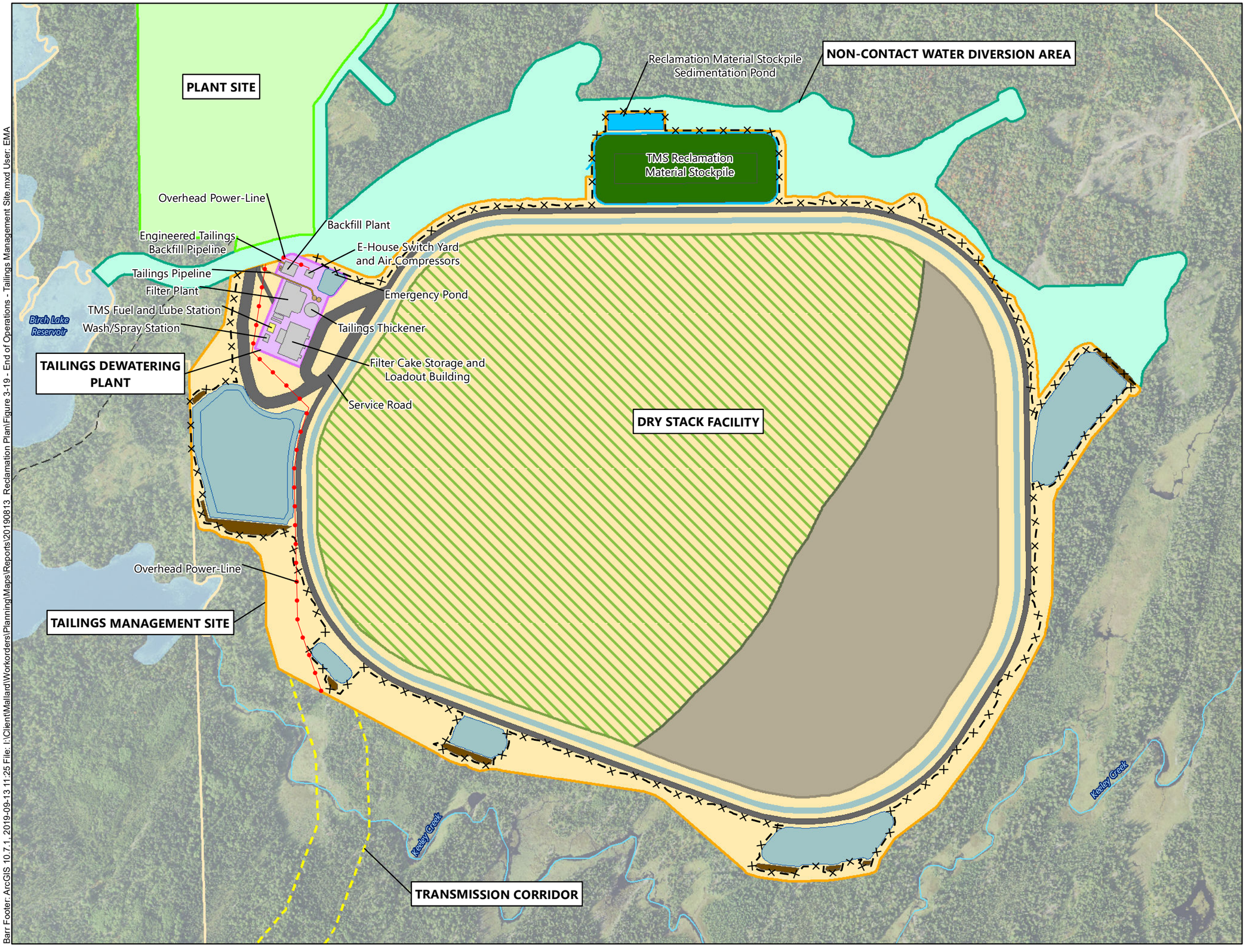
N

0 500 1,000 2,000
Feet

0 125 250 500
Meters

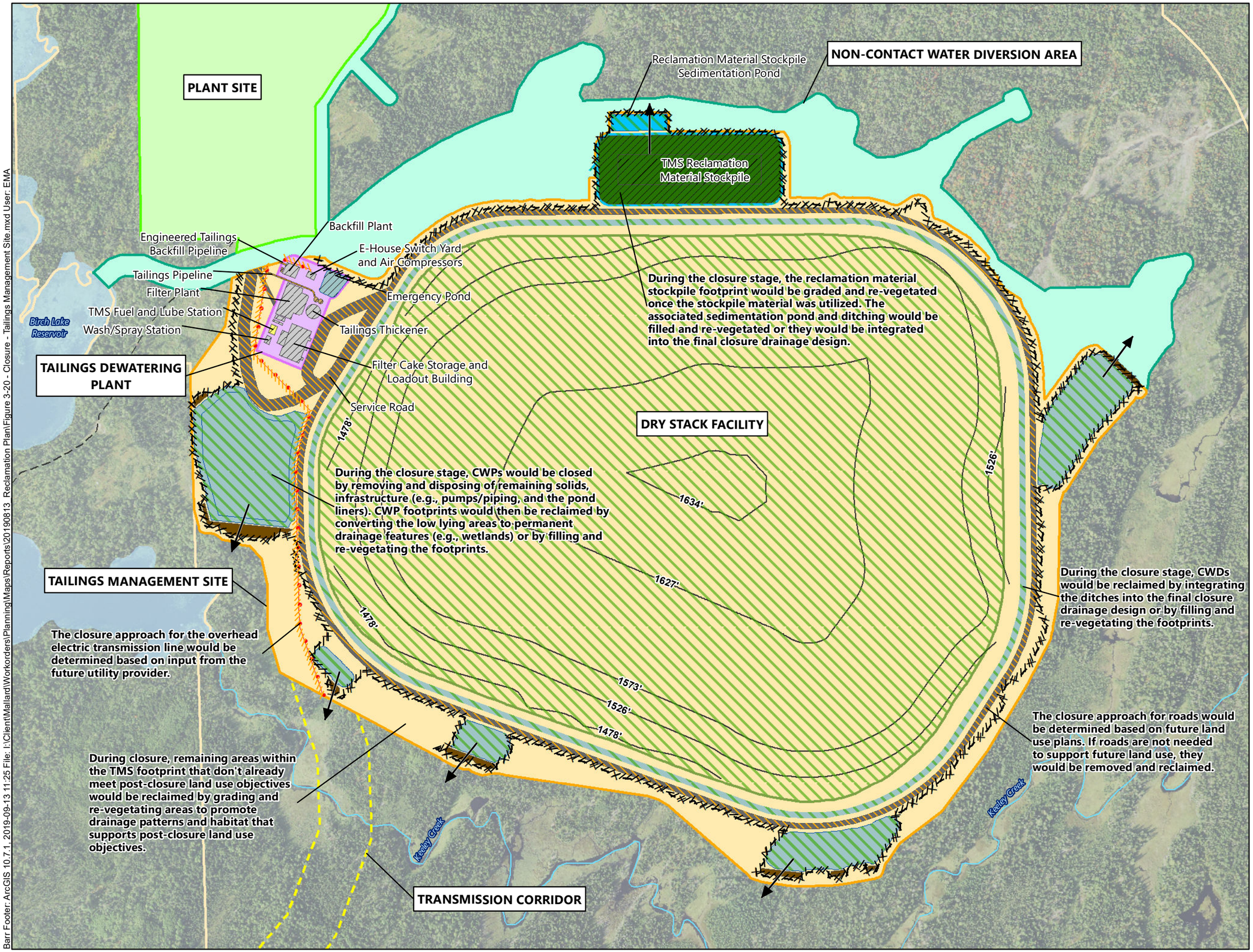
Figure 3-18
INCREMENTAL DEVELOPMENT AND CONCURRENT RECLAMATION - DRY STACK FACILITY
Twin Metals Minnesota LLC
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:38 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-18 - Incremental Development and Concurrent Redamation - DSF.mxd User: EMA



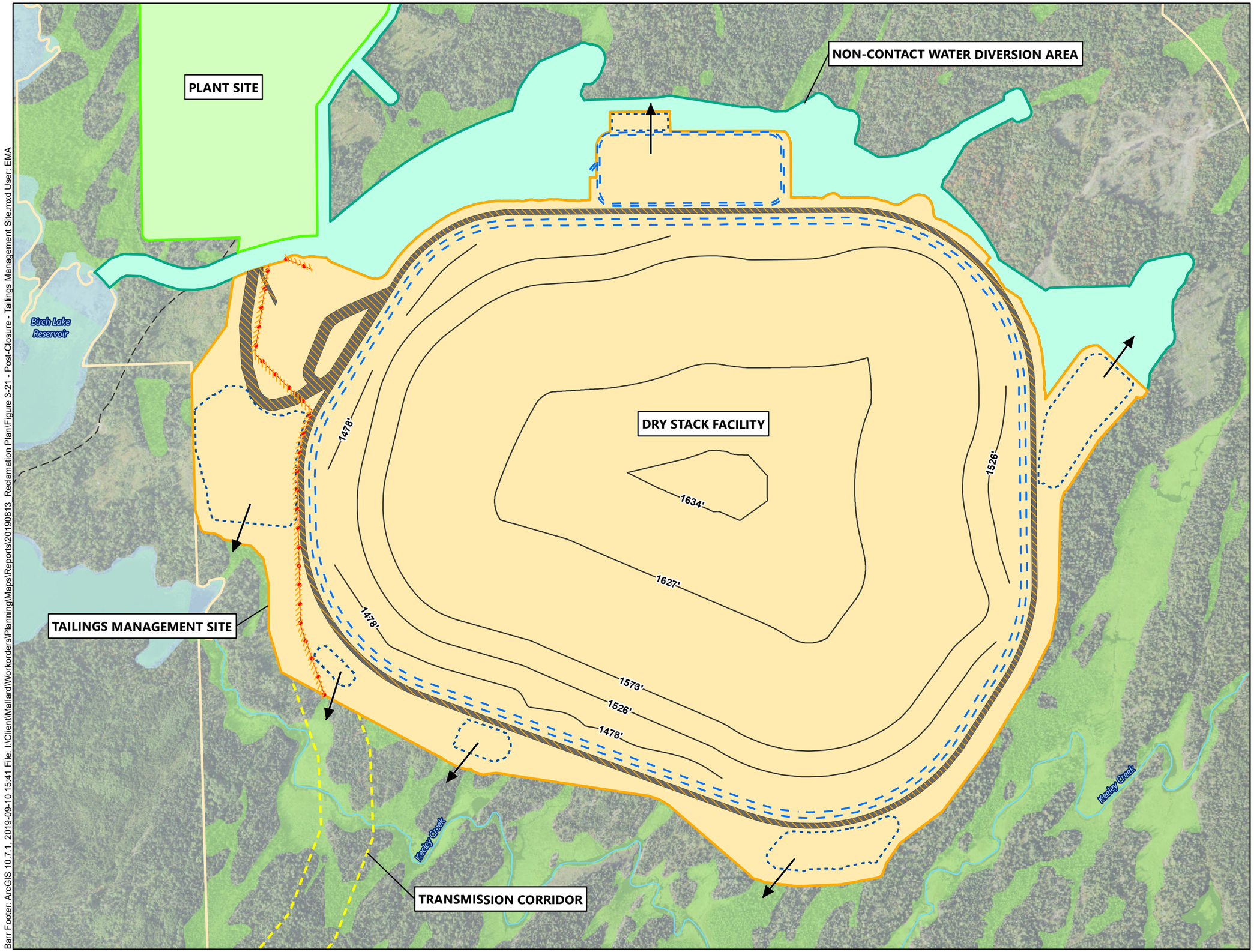
Barr Footer: ArcGIS 10.7.1, 2019-09-13 11:25 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-19 - End of Operations - Tailings Management Site.mxd User: EMA

Figure 3-19
END OF OPERATIONS - TAILINGS MANAGEMENT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN



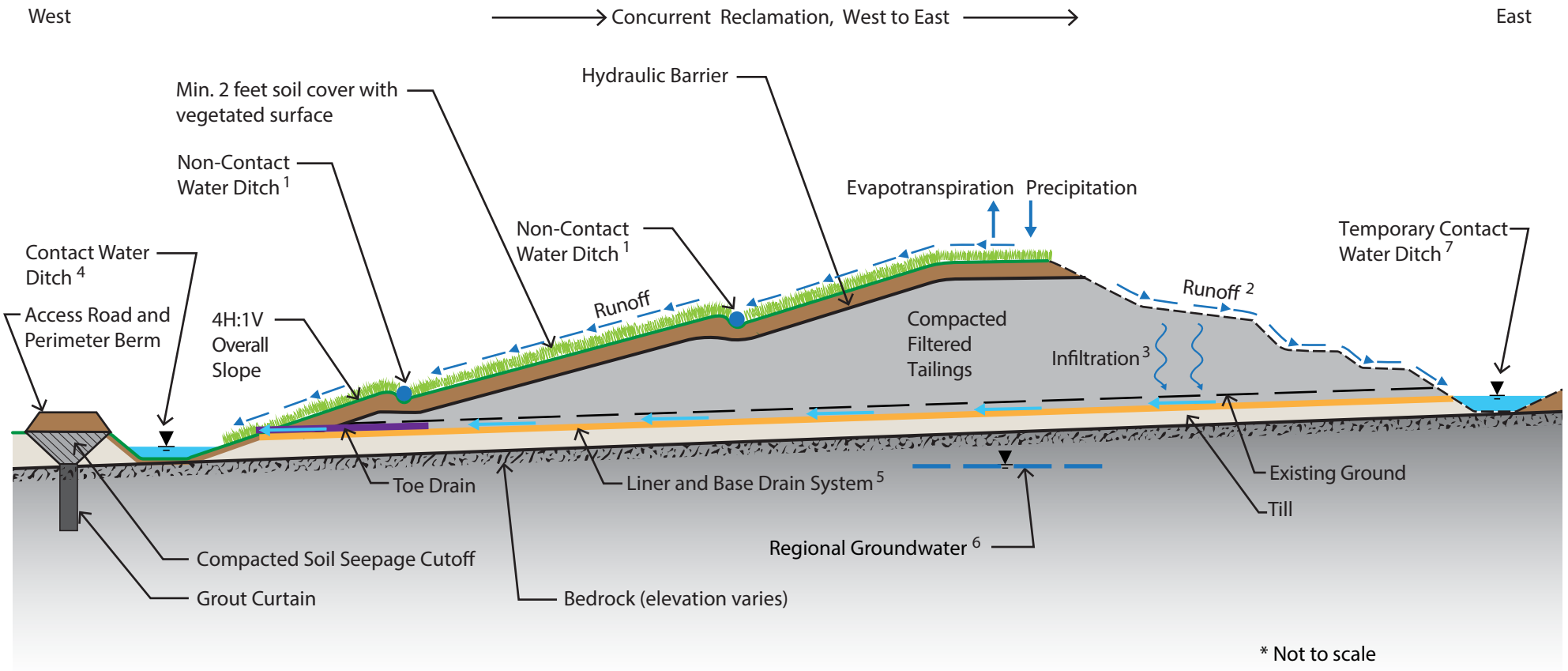
Barr Footer: ArcGIS 10.7.1, 2019-09-13 11:25 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-20 - Closure - Tailings Management Site.mxd User: EMA

Figure 3-20
CLOSURE - TAILINGS MANAGEMENT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN



Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:41 File: I:\Client\Mallard\Workorders\PlanningMaps\Reports\20190813_Reclamation Plan\Figure 3-21 - Post-Closure - Tailings Management Site.mxd User: EMA

Figure 3-21
POST-CLOSURE - TAILINGS MANAGEMENT SITE
Twin Metals Minnesota
Lake and St. Louis Counties, MN



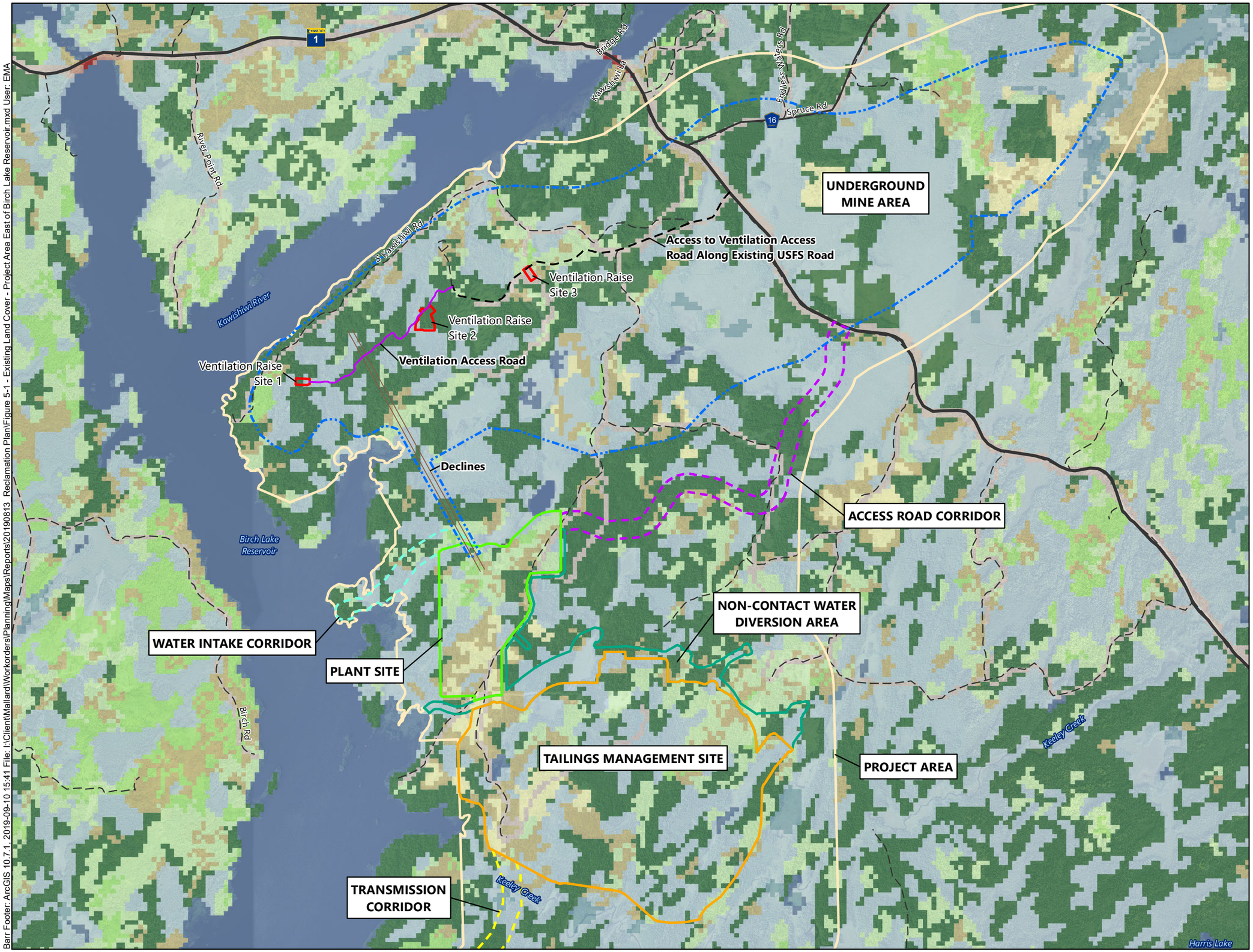
Notes

1. Non-contact water runoff would be collected in non-contact water ditches (NCWDs) on the exterior slope of the DSF to convey water toward the toe of DSF perimeter embankment. Initially (including during concurrent reclamation) the NCWDs on the DSF would drain to controls for removal of suspended solids (e.g., dedicated settling / detention ponds, not shown on this concept figure). Water from non-contact water controls would drain to the environment following removal of suspended solids.
2. Within the active area of the DSF where placed tailings are not covered, surface water that contacts tailings would be collected and routed to contact water ditches (CWDs).
3. Water that infiltrates into the tailings must resaturate the tailings along a vertical preferential flow path to the base of the DSF. Only then will water reach the drain system. Water that infiltrates into the tailings and fully flows through the tailings would be collected in the over-liner drain system (part of the base drain system) that would also drain to CWDs around the perimeter of the DSF.
4. CWDs would drain to lined contact water ponds (CWPs, not shown on this concept figure). Water in CWPs would be returned to the plant site process water circuit, used for tailings conditioning and particulate emissions control within the DSF, and/or be used for preparation of cemented tailings backfill. Once the DSF surface was fully revegetated and vegetation growth is dense and well established, runoff may no longer require suspended solids removal to meet water quality standards. Once suspended solids removal is no longer necessary, runoff would be discharged directly to the environment.
5. The DSF liner and base drain system would include a geomembrane and compacted soil liner and a two-part drainage system consisting of 1) over-liner gravel drains to aid removal of any seepage that would occur through the tailings and otherwise pond on the geomembrane liner and 2) under-liner gravel drains to control soil pore-water below the geomembrane liner.
6. Locally depressed regional groundwater resulting from reduced recharge and perimeter grout curtain.
7. Temporary ditching would be provided to convey runoff from the open face of the DSF to the perimeter of the CWDs.

Figure 3-22

TMS SITE
CONCEPTUAL MODEL -
DRY STACK FACILITY
Twin Metals Minnesota LLC
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-08-09 09:30 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 3-22 - TMS Site Conceptual Model.pdf



Project Area
Underground Mine Area (Surface Projection)
Plant Site
Tailings Management Site
Non-Contact Water Diversion Area
Access Road Corridor
Transmission Corridor
Water Intake Corridor
Ventilation Raise Site
Declines
Ventilation Raise Access Road
USFS Roads (2013)

Streets and Highways (MnDOT)
State Trunk Highway
County State-Aid Highway

National Land Cover Data (USGS 2011)
Woody Wetlands
Shrub/Scrub
Open Water
Mixed Forest
Herbaceuous
Evergreen Forest
Emergent Herbaceuous Wetlands
Developed, Open Space
Developed, Low Intensity
Developed, High Intensity
Deciduous Forest

N

0 1,000 2,000 4,000
Feet
0 300 600 1,200
Meters

Figure 5-1
EXISTING LAND COVER - PROJECT AREA EAST OF BIRCH LAKE RESERVOIR
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-09-10 15:41 File: I:\Client\Mallard\Workorders\Planning\Maps\Reports\20190813_Reclamation Plan\Figure 5-1 - Existing Land Cover - Project Area East of Birch Lake Reservoir.mxd User: EMA

ATTACHMENT B.1

TMM PROJECT RECLAMATION PLAN SUMMARY

Table A1 TMM Project Reclamation Plan Summary

Project Area and Feature	General Reclamation Approach[1]	RECLAMATION					
		Operations	Closure Year			Post-Closure Maintenance and Monitoring Year	
Underground Mine Area		25 year LOM	1	2	3	Years 1 through 5	Years 5 through 25
- Underground mobile equipment and infrastructure	Remove						
- Underground fixed equipment and infrastructure	Abandon in place						
- Mine decline and underground mine[2]	Backfill[3], passively flood unfilled portions						
- Ventilation shafts and surface ventilation structures[2]	Remove infrastructure, bulkhead/seal shafts						
- Disturbed land surface at surface ventilation structures	Regrade and revegetate[4]						Through Year 10
Plant Site			1	2	3	Years 1 through 5	Years 5 through 25
- Portals to the underground mine[2]	Permanently seal to prevent access						
- Buildings	Remove[5] and regrade/revegetate footprint						
- Electrical/power	Remove general items, leave the substation and power-line from the offsite substation in place[6,7]						
- Supporting equipment and infrastructure	Remove[5] and regrade/revegetate footprint						
- Fuel storage	Remove and regrade/revegetate footprint						
- Pipelines	Remove						
- Laydown and storage areas	Remove and regrade/revegetate footprint						
- Ponds	Remove, regrade and/or fill, and revegetate footprint						
- Service roads and parking areas	Retain if needed to support future land use, otherwise remove and regrade/revegetate footprint						
- Stockpiles (including liners if present)	Remove and regrade/revegetate footprint						
- Sanitary management systems	Pump out and remove tanks						
- Surface water management features	Regrade and revegetate[5]						
- Ancillary disturbed land surface at Plant Site	Regrade and revegetate[4]						Through Year 10
Corridors			1	2	3	Years 1 through 5	Years 5 through 25
- Access road	Retain/maintain						
- Water intake pipeline (from Birch Lake reservoir)	Remove (or abandon in place if approved)						
- Water intake facility	Remove and regrade/revegetate footprint						
- Water intake pipelines (intake facility to plant site)	Flush, remove						
- Water intake communications and power supply	Abandon in place						
- Water intake maintenance access roads	Regrade and revegetate[5]						
- Transmission corridor power-lines and off-site substation	Leave in place[6,7]						
- Surface water management	Regrade and revegetate[5]						
- Ancillary disturbed land surface along corridors	Regrade and revegetate[4]						Through Year 10
Non-contact Water Management Area (NWDA)			1	2	3	Years 1 through 5	Years 5 through 25
- Dikes	Revegetate and leave in place[6]						
- Native soil fill areas	Revegetate and leave in place[6]						
- Non-contact water ponds	Leave in place[6]						
- Non-contact water ditches	Revegetate and leave in place[6]						
- Culverts	Leave in place[6]						
- Ancillary disturbed land surface in NWDA	Regrade and revegetate[4]						
Tailings Management Site (TMS)			1	2	3	Years 1 through 5	Years 5 through 25
- Buildings at the tailings dewatering plant	Remove[5] and regrade/revegetate footprint						
- Pipelines	Remove						
- Dry stack facility (including ditches)	Revegetate and leave in place[6,7]						
- Contact water ponds and ditches[8]	Drawdown, stabilize, reclaim footprint						
- Electrical/power	Remove general items, leave the power-line from the plant site to the TMS in place[6,7]						
- Stockpiles	Remove and regrade/revegetate footprint						
- Service roads and parking	Retain if needed to support future land use, otherwise remove and regrade/revegetate footprint						
- Laydown and storage areas	Remove and regrade/revegetate footprint						
- Ancillary disturbed land surface at TMS	Regrade and revegetate[4]						Through Year 10
Other Supporting Infrastructure and Activities [9]			1	2	3	Years 1 through 5	Years 5 through 25
- Groundwater monitoring wells and monitoring	Reclaim when no longer needed						
- Surface water monitoring stations and monitoring	Remove when no longer needed						

Notes:

1) See written Reclamation Plan for additional location-specific reclamation approach and requirements.

2) Monitor for ground subsidence at portal and ventilation raise site reclaim areas, and above first 2,000 feet of mine decline through Post-Closure Year 5.

3) During the operations Project stage, the underground workings would be progressively backfilled with an engineered tailings backfill (ETB) produced at the surface and distributed via the declines through the underground workings using a system of pipes and lines secured within the stopes and drifts. Generally establish conditions to minimize concentrated flow and limit flow velocities such that, together with the vegetated cover, the resulting site will be stabilized, with peak discharge rates not exceeding pre-mining conditions.

4) Regrade footprint and revegetate to promote drainage patterns and habitat that support post-closure land use objectives (e.g., range of mixed hardwood pine forest to jack pine barrens except at TMS which will be a diverse grasslands with pollinator species).

Legend:

- Concurrent reclamation (reclamation performed during the operations stage).
- Closure activity during primary closure period (closure years 1 through 3).
- Closure activity during post-closure maintenance.
- Post-closure maintenance and monitoring (higher intensity level).
- Post-closure maintenance and monitoring (lower intensity level).
- To be determined based on future land use needs
- No activity/action planned or required.

5) Foundation walls two feet and greater below final grade, abandoned in place.

6) "Leave in place" means that infrastructure is maintained for use (or potential future use) (whereas "abandon in place" means the infrastructure is no longer in use and will not be maintained for future use).

7) Future use to be determined based on input the from the utility provider.

8) Generally re-establish pre-mining runoff flow directions and discharge locations.

9) Groundwater and surface water monitoring requirements to be reviewed and updated periodically.

ATTACHMENT B.2

RECLAMATION PLANS – SYNOPSIS OF RULES

This synopsis of rules is intended to help the reader understand potential rules pertaining to Project reclamation that Twin Metals Minnesota LLC would need to comply with. The synopsis is not intended to be a comprehensive description of all applicable rules. Rather, as context for the reader, the synopsis provides general background related to potential reclamation rules. As discussed in Section 1.2 of the Reclamation Plan, TMM would need to comply with all applicable reclamation requirements set forth in federal or state surface authorizations, mineral leases, permits, and applicable land management plans. TMM expects that specific reclamation requirements will be developed during the environmental review and permitting process.

Minnesota Rules Part 6132.1100 Permit Applications

Subp.6. Mining and Reclamation Plan, Item C requires inclusion of "the engineering design, methods, sequence, and schedules of reclamation including closure and postclosure maintenance that address the goals and meet the requirements of parts 6132.2000 to 6132.3200, including anticipated reclamation research…"

Subp.7.Mining and Reclamation Maps, Item D(3) requires maps showing construction, including shape, extent, and content, and reclamation, including contouring, covering, temporary stabilization, vegetation, closure, and post-closure maintenance, of each of the following: storage pile, tailings basin, mine reservoir, dam, diversion channel, drainage control, settling basin, heap and dump leaching facility, and auxiliary facility.

Minnesota Rules Part 6132.1200 Financial Assurance

Requirements of 6132.1200 are not repeated herein. In summary, financial assurance must be provided and is to assure that there are sufficient funds to be used by the MDNR commissioner if the permittee fails to perform:

A. reclamation activities including closure and post-closure maintenance needed if operations cease; and
B. corrective action as required by the commissioner if noncompliance with design and operating criteria in the permit to mine occurs.

A Plan on which financial assurance cost estimates are based must be prepared.

Minnesota Rules Part 6132 Reclamation Standards

- 6132.2000 Siting – not applicable to Reclamation Plan.
- 6232.2100 Buffers – requires visual buffers to diminish visual impacts of mining.
- 6132.2200 Reactive Mine Waste – must be reclaimed to prevent the release of substances that result in the adverse impacts on natural resources.

- 6132.2300 Overburden Portion of Pit Walls – underground mine proposed; not applicable.
- 6132.2400 Storage Pile Design – permanent storage piles not proposed; not applicable.
- 6132.2500 Tailings Basins – must be designed to be structurally sound, control air emissions, minimize hydrogeologic impacts, promote progressive reclamation, and enhance the survival and propagation of vegetation, and include provisions for closure and postclosure maintenance.
- 6132.2600 Heap and Dump Leaching Facilities – none proposed; not applicable.
- 6132.2700 Vegetation – must be established to control erosion, screen mining areas from noncompatible uses, and provide for subsequent land uses such as wildlife habitat or timber production.
    - After three growing seasons following initiation of vegetation, a 90 percent ground cover within a 90 percent statistical confidence interval, consisting of living vegetation and its litter, must exist on all areas, except slopes that primarily face south and west. Such slopes shall attain the 90 percent ground cover in 5 growing seasons.
    - Within ten growing seasons following initiation of vegetation, an area shall have a vegetative community with characteristics similar to those of an approved reference area. The vegetation on a reference area may be either planted or naturally occurring……Reference areas must be representative of the site conditions and possible uses that might exist on mining land forms.
- 6132.2800 Dust Suppression – areas disturbed by mining shall be managed to control dust.
- 6132.2900 Air Overpressure and Ground Vibration From Blasting – not applicable to reclamation.
- 6132.3000 Subsidence – areas affected by subsidence shall be contoured or filled to protect public health and safety or natural resources.
- 6132.3100 Corrective Action – corrective action required if non-compliance with permit occurs and in the event of a threat to human safety or natural resources resulting from the mining operation.
- 6132.3200 Closure and PostClosure Maintenance – the mining area shall be closed so that it is stable, free of hazards, minimizes hydrologic impacts, minimizes the release of substances that adversely impact other natural resources, and is maintenance free.

Minnesota Rules Part 6132.3200 Closure and Post-closure Maintenance

Requirements of 6132.3200 are not repeated herein. In summary, 6132.3200 outlines specific closure and post-closure actions and schedule requirements.

FSM Chapter 2840 – Reclamation

Reclamation is defined as "Those actions performed during or after mineral activities (defined as any aspect of mineral exploration, development, or production) to shape, stabilize, revegetate, or otherwise treat the affected lands in order to achieve a safe and ecologically stable condition and land use that is consistent with long-term forest land and resource management plans and local environmental conditions."

Administrative and Environmental Reclamation components required for Plans of Operations include:

1. Administrative Components
    a. Timing, kind, and amount of reclamation to be accomplished concurrently with mineral activities.
    b. Reclamation requirements for interim shutdown, including seasonal shutdown.
    c. The maximum allowable time in the event of interim shutdown before final reclamation measures will be required.
    d. Concurrent and final reclamation of transportation facilities, such as roads, railways, tramways, power line corridors, and pipelines.
    e. Removal of facilities and reclamation of the site.
    f. Timeframes for periodic review and updating of the Plan of Operations, including reclamation performance requirements and financial guarantees. Procedures for ensuring interim and final stability of waste embankments, including dumps, tailings dams, or impoundments.

2. Environmental Components
    a. Final configuration of the disturbed areas, including such items as roads, pits, waste embankments, ponds, leach pads, drill holes, and facility sites.
    b. Revegetation of disturbed areas, including timing, kind, and amount.
    c. Topsoil management, including soil salvage and reapplication.
    d. Air quality management during and after operations.
    e. Watershed management, including runoff and erosion control, and riparian and wetland protection.
    f. Water quality management, including physical and chemical characteristics of surface and subsurface water during and after operations.
    g. Visual resource management during and after operations.
    h. Potential for the occurrence and control of hazardous or toxic substances, including acid mine drainage, that may contaminate air, water or soil.
    i. Fish and wildlife habitat reclamation or mitigation.
    j. Tailings and associated tailings facilities.
    k. Stream diversions, reservoirs, ditches, or canals.

In addition to the components summarized above, measurable Reclamation Performance Standards must be included for at least the following:

1. Revegetation
2. Soil and water conservation measures.
3. Mass stability of overburden and other waste embankments.
4. Concurrent reclamation.
5. Post-mining and configuration.

43 CFR Part 3800, Subpart 3809.420 – Reclamation performance standards are described in 3809.420 part a. General Performance Standards and part b3. Specific Standards – Reclamation

(a) General performance standards -

(1) Technology and practices. You must use equipment, devices, and practices that will meet the performance standards of this subpart.

(2) Sequence of operations. You must avoid unnecessary impacts and facilitate reclamation by following a reasonable and customary mineral exploration, development, mining and reclamation sequence.

(3) Land-use plans. Consistent with the mining laws, your operations and post-mining land use must comply with the applicable BLM land-use plans and activity plans, and with coastal zone management plans under 16 U.S.C. 1451, as appropriate.

(4) Mitigation. You must take mitigation measures specified by BLM to protect public lands.

(5) Concurrent reclamation. You must initiate and complete reclamation at the earliest economically and technically feasible time on those portions of the disturbed area that you will not disturb further.

(6) Compliance with other laws. You must conduct all operations in a manner that complies with all pertinent Federal and state laws.

(b3) Specific standards - Reclamation

(i) At the earliest feasible time, the operator shall reclaim the area disturbed, except to the extent necessary to preserve evidence of mineralization, by taking reasonable measures to prevent or control on-site and off-site damage of the Federal lands.

(ii) Reclamation shall include, but shall not be limited to:

A. Saving of topsoil for final application after reshaping of disturbed areas have been completed;
B. Measures to control erosion, landslides, and water runoff;
C. Measures to isolate, remove, or control toxic materials;
D. Reshaping the area disturbed, application of the topsoil, and revegetation of disturbed areas, where reasonably practicable; and
E. Rehabilitation of fisheries and wildlife habitat.

(iii) When reclamation of the disturbed area has been completed, except to the extent necessary to preserve evidence of mineralization, the authorized officer shall be notified so that an inspection of the area can be made.

Per the BLM Surface Management Handbook (H-3809-1) Section 3.2.1.2.3 Reclamation Plan:

The operator must provide sufficient information for the BLM to assess the adequacy of the proposed reclamation plan. This may involve the operator providing a description of the equipment, devices, or practices they propose to use during reclamation to meet the performance standards. The reclamation plan must provide for the regrading and reshaping of disturbed areas, where applicable. Typical reclamation plans should include a description of the equipment to be used, slope grade, location and size of runoff controls, cross-sections, etc. A post-grading topographic map showing the planned regrading, though not required, can be the best way to illustrate the regrading plan. The reclamation plan needs to describe the location, plant species, seeding or planting rates, and treatment methods proposed to re-establish vegetation over disturbed areas. Also, the plan must propose the criteria for what would constitute successful revegetation and describe additional measures, such as temporary fencing or noxious weed control, which might be used on the reclaimed area. Where applicable, the reclamation plan must describe how drill holes are going to be plugged. The District/Field Office's review must verify that plugging procedures will be in compliance with applicable state drill-hole plugging requirements.

Title 43 of Code of Federal Regulations (CFR) Part 3500, Subpart 3592.1 – Operating Plans

(a) Before conducting any operations under any lease(s), license(s), or permit(s), the operator shall submit to the authorized officer an exploration or mining plan which shall show in detail the proposed exploration, prospecting, testing, development or mining operations to be conducted. Exploration and mining plans shall be consistent with and responsive to the requirements of the lease, license or permit for the protection of non-mineral resources and for the reclamation of the surface of the lands affected by the operations on Federal or Indian lease(s), license(s), or permit(s). The authorized officer shall consult with any other agency involved, and shall promptly approve the plans or indicate what additional information is necessary to conform to the provisions of the established requirements. No operations shall be conducted except as provided in an approved plan……

(9) A reclamation schedule and the measures to be taken for surface reclamation of the Federal or Indian lease(s), license(s), or permit(s) that will ensure compliance with the established requirements. In those instances in

which the lease requires the revegetation of an area affected by operations, the mining plan shall show:

(i) Proposed methods of preparation and fertilizing the soil prior to replanting;

(ii) Types and mixtures of shrubs, trees or tree seedlings, grasses or legumes to be planted; and

(ii) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees or tree seedlings, or combinations of grasses and trees;

(10) The method of abandonment of operations on Federal or Indian lease(s), license(s), and permit(s) proposed to protect the unmined recoverable reserves and other resources, including the method proposed to fill in, fence or close all surface openings which are a hazard to people or animals. Abandonment of operations also is subject to the provisions of subpart 3595 of this title; and

(11) Any additional information that the authorized officer deems necessary for approval of the plan.

Title 43 CFR Part 3500, Subpart 3595.1 – Surface Openings

(a) The operator/lessee shall substantially fill in, fence, protect or close all surface openings, subsidence holes, surface excavations or workings which are a hazard to people or animals. Such protective measures shall be maintained in a secure condition during the term of the lease, license or permit. Before abandonment of operations, all openings, including water discharge points, shall be closed to the satisfaction of the authorized officer.

(b) Reclamation or protection of surface areas no longer needed for operations will commence without delay. The authorized officer shall designate such areas where restoration or protective measures, or both shall be taken.

Title 43 CFR Part 3500, Subpart 3595.2 – Abandonment of Underground Workings

No underground workings or part thereof shall be permanently abandoned and rendered inaccessible with-out the advance, written approval of the authorized officer.

CFR Title 36 Parks, Forests and Public Property, Part 228 Minerals *(applicable to operations on National Forest System lands under the jurisdiction of the Secretary of Agriculture)*

Reclamation requirements outlined in Subpart 228.8 (g) are stated as follows:

Upon exhaustion of the mineral deposit or at the earliest practicable time during operations, or within one year of the conclusion of operations, unless a longer time is allowed by the authorized officer, operator shall, where practicable, reclaim the surface disturbed by taking such measures as will prevent or control onsite and off-site damage to the environment and the forest surface resources including:

1. Control of erosion and landslides;
2. Control of water runoff;
3. Isolation, removal or control of toxic materials;
4. Reshaping and revegetation of disturbed areas, where reasonably practicable; and
5. Rehabilitation of fisheries and wildlife habitat.

Reclamation requirements outlined in Part 228.10 are stated as follows:

> Unless otherwise agreed to by the authorized officer, operator shall remove within a reasonable time following cessation of operations all structures, equipment and other facilities and clean up the site of operations.

APPENDIX C

NON-CONTACT WATER MANAGEMENT PLAN

NON-CONTACT WATER MANAGEMENT PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared by Twin Metals Minnesota LLC

Document No. TMM-EG-115-0003
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	N/A	1.0

REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PURPOSE 1
2.0 NON-CONTACT WATER MANAGEMENT 1
2.1 NON-CONTACT WATER DIVERSION AREA 2
2.1.1 Monitoring 3
2.1.2 Maintenance 3
2.2 PLANT SITE 3
2.2.1 Monitoring 4
2.2.2 Maintenance 4
2.3 TAILINGS MANAGEMENT SITE 4
2.3.1 Tailings Management Site Reclamation Material Stockpile 4
2.3.2 Undeveloped Portion of the Tailings Management Site 5
2.3.3 Exposed Dry Stack Facility Liner 5
2.3.4 Portion of the Tailings Dewatering Plant 5
2.3.5 Reclaimed Portion of the Dry Stack Facility 5
2.3.6 Monitoring of Tailings Management Site Non-Contact Area 6
2.3.7 Maintenance of Tailings Management Site Non-Contact Area 6
2.4 UNDERGROUND MINE AREA 6
2.5 CORRIDORS 7

FIGURES

Located in Figures section at end of document:

Figure 1-1 General Project Layout
Figure 1-2 Plant Site and Tailings Management Site Operations General Arrangement Plan
Figure 2-1 Non-contact Water Diversion Area Surface Water Flow Direction

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

BMP Best Management Practice

e.g.	Latin phrase *exemplis gratia* meaning “for example”
etc.	abbreviation for the Latin phrase et cetera meaning "and other similar things" or "and so forth"
ft	foot
km	kilometer
m	meter
Project	Twin Metals Minnesota Project
TMM	Twin Metals Minnesota LLC

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process.

1.1 Purpose

The following Non-contact Water Management Plan has been prepared as part of the Project's mine plan of operations to inform management of non-contact water. The contents of this Non-contact Water Management Plan include monitoring and management guidance for the following:

- Non-contact water diversion area:
  - non-contact water ditches;
  - non-contact water ponds;
- Plant site non-contact area; and
- Tailings management site non-contact area.

The overall Project layout is presented in Figure 1-1 and a more detailed Project layout of non-contact water management features is presented in Figure 1-2. This is intended to be a living document and would be updated as necessary, during the Project's environmental review process. Updates would be submitted to the lead agency prior to construction.

2.0 NON-CONTACT WATER MANAGEMENT

Non-contact water would be managed in the following areas:

- Non-contact water diversion area;
- Plant site non-contact area;
- Tailings management site non-contact area;
- Underground Mine Area non-contact area; and

- Corridors.

Best Management Practices (BMPs) would be used across the Project to manage non-contact water. BMPs may include, but are not limited to, mulching and biodegradable erosion control blankets, establishing and maintaining vegetation, collection and conveyance structures (e.g., swales, ditches, and culverts), non-vegetative soil stabilization such as rock armoring and sediment barriers or basins.

2.1 Non-Contact Water Diversion Area

Non-contact water from the adjacent watersheds would be intercepted and diverted around the plant site and the tailings management site to prevent non-contact water from co-mingling with contact water and to protect infrastructure. Figure 2-1 illustrates the surface water flow direction within the non-contact water diversion area.

To divert non-contact water around the plant site, two non-contact water ditches would be constructed to intercept and divert water to the south. To divert non-contact water around the tailings management site, non-contact water ditches and diversions dikes would be constructed in stages, corresponding to the staged development of the dry stack facility.

The five diversion dikes around the north side of the tailings management site would be offset at least 328 ft (100 m) from the outer edge of the perimeter haul road. These diversion dikes would be staged concurrently with the dry stack facility construction stages. They would be constructed by placing and compacting fill across drainage depressions, as required, and armoring the upstream side with riprap. These dikes would result in ponding of non-contact water from adjacent surface flows resulting in non-contact water ponds. Four non-contact water ditches would be built to drain ponded water from the diversion dikes on the north side of the tailings management site to Birch Lake reservoir.

Three diversion dikes and a non-contact water ditch on the northeast side of the tailings management site would intercept and divert water to the east. Water impounded on the east side of the most eastern diversion dike would eventually overtop a “saddle” and flow out of the drainage course into a tributary of Keeley Creek.

The diversion dikes would be designed to hold back the runoff from a 100-year, 24-hour storm event while maintaining a minimum 3.3 feet (ft) ft (1 meter [m]) of freeboard. The non-contact water ditches would be designed to convey the peak flow from a 10-year, 24-hour storm event with no erosion. The overflow weirs and non-contact water ditches would be designed to convey the 100-year, 24-hour storm event with a minimum freeboard of 1 ft (0.3 m). The diversion ditches would be designed with the appropriate slope to control suspended sediment. The non-contact

water ditches would discharge to existing drainage ways or other diversions ditches through energy dissipation devices (e.g., rip-rap, erosion control mats, etc.).

2.1.1 Monitoring

The non-contact water ponds, non-contact water ditches, and diversion dikes would be inspected on a regular basis at a frequency determined necessary by regulatory authorities. The non-contact water ponds, non-contact water ditches, and diversion dikes would be inspected monthly and during and after significant precipitation events. The inspections would look for ongoing erosion or sedimentation in the ditches which could impede their function.

2.1.2 Maintenance

When sediment deposits in the non-contact water ditches reach levels that could adversely affect flow capacity, the sediments would be excavated and deposited onto the reclamation material stockpile to re-establish flow capacity. If the base or side slopes of the non-contact water ditches experience erosion or slumping after a significant runoff event, the ditch profile would be restored, and the ditch would be reseeded with grass vegetation or riprap armoring would be placed/replaced.

2.2 Plant Site

A portion of the plant site would be managed as a non-contact area to allow flexibility for water management during extreme storm events. During extreme storm events, stormwater on the non-contact area at the plant site would be routed through appropriate discharge controls. However, during typical precipitation years, stormwater from the non-contact area at the plant site would be routed to and collected by the contact water collection system and used in the process. The collection of stormwater managed as contact water at the plant site is discussed in the Contact and Process Water Management Plan.

The non-contact area at the plant site would include, the security gatehouse, reclamation material stockpile 1 and 2, the plant site electrical substation, the ball storage bunker, the concentrator, the concentrator services building, the reagent storage building, and the areas surrounding and connecting these facilities that are not directly involved in transport of ore or tailings by truck. The slopes of the working pad at the plant site would be a non-contact area and designed to limit erosion so stormwater from the slopes would be routed through appropriate discharge controls. Based on the operational water needs for the process at the time of storm events, water from the non-contact area would be either diverted away from the plant site to minimize the amount of contact water collected from the plant site or collected by the contact water collection system.

During clearing and grubbing, non-saleable lumber would be chipped and used to cover reclamation material stockpile 1 and 2 to prevent wind and water erosion. Other sediment control features would be installed as needed.

2.2.1 Monitoring

The plant site non-contact zone would be inspected on a regular basis at a frequency determined necessary by regulatory authorities.

2.2.2 Maintenance

Erosion features in reclamation material stockpiles 1 and 2 would be repaired and the surface would be reseeded as needed. If necessary, the areas would be treated with a temporary erosion control measure (e.g., erosion control mat). If sediment accumulates in the reclamation material stockpile perimeter ditch and impedes flow, the sediment would be excavated from the ditch and deposited on the reclamation material stockpile. If sediment accumulates in the reclamation material stockpile sedimentation pond to the point where it restricts flow through the pond or significantly limits the detention capacity of the pond, the sediment would be excavated and deposited on the reclamation material stockpile.

2.3 Tailings Management Site

The tailings management site would manage the following five main non-contact areas:

1. Tailings management site reclamation material stockpile;
2. Undeveloped portions of the tailings management site prior to development of stage 2 and 3;
3. Portion of the exposed dry stack facility liner prior to tailings filter cake placement;
4. Portion of the tailings dewatering plant; and
5. Reclaimed portion of the dry stack facility.

2.3.1 Tailings Management Site Reclamation Material Stockpile

The tailings management site reclamation material stockpile would be classified as a non-contact area. Stormwater would be captured in perimeter ditches which would discharge into the reclamation material stockpile sediment pond. The tailings management site reclamation material stockpile sedimentation pond outlet would be to the north, with an ultimate outlet through the non-contact water ditch to the west. Erosion of the reclamation material stockpile would be limited through seeding of the stockpile surface with grass and temporary erosion control measures (e.g. silt fencing) until vegetation is established.

2.3.2 Undeveloped Portion of the Tailings Management Site

Prior to development of the dry stack facility stage 2 and stage 3, the footprint of stage 2 and stage 3 would be undeveloped. Stormwater on the undeveloped land would be non-contact water and would continue to flow around the dry stack facility footprint unaffected by dry stack facility development and tailings filter cake placement on stage 1. The footprint of dry stack facility stage 3 would be managed as non-contact water during operations when tailings filter cake is placed on stage 2.

2.3.3 Exposed Dry Stack Facility Liner

Development of the dry stack facility would result in exposed sections of the dry stack facility liner prior to tailings filter cake being placed and compacted. Portions of the exposed dry stack facility liner would be managed as non-contact areas. These non-contact areas would be identified and managed with a separation between contact water and non-contact water. Water from the non-contact areas of the exposed dry stack facility liner would be continually updated as the placement of tailings filter cake progresses eastward.

2.3.4 Portion of the Tailings Dewatering Plant

A portion of the tailings dewatering plant would be managed as a non-contact area to allow flexibility for water management during extreme storm events. During extreme storm events, stormwater on the non-contact area at the tailings dewatering plant would be routed through appropriate discharge controls. However, during typical precipitation years, stormwater from the non-contact area at the tailings dewatering plant would be routed to and collected by the contact water collection system and used in the process.

2.3.5 Reclaimed Portion of the Dry Stack Facility

During concurrent reclamation of the dry stack facility, a cover system would be installed. The final dry stack facility cover system would consist of a cover soil underlain by a hydraulic barrier. The cover system would be designed to function as a growth medium to support revegetation, reclassify the covered area of the dry stack facility as a non-contact water area and acting as a hydraulic barrier to mitigate the generation of draindown and / or seepage during closure.

Tailings filter cake would be preferentially placed to promote runoff and inhibit infiltration as part of operations. It would likely require relatively little grading to establish a finished slope towards the perimeter of the dry stack facility. The contouring of the dry stack facility surface required for reclamation and placement of cover material would be continued in a manner that promotes runoff and inhibits infiltration.

Portions of the dry stack facility which have been concurrently reclaimed would no longer generate contact water and stormwater runoff would be managed as non-contact water. In these areas, a temporary non-contact water ditch would be constructed near the toe of the dry stack facility inside and above the contact water ditches. These non-contact water ditches would drain to sediment control features to remove suspended solids. Controls for suspended solids removal may include but are not limited to temporary dedicated settling / detention ponds. Control features would drain to the surrounding areas following removal of suspended solids.

The post-closure surface of the dry stack facility would be graded to drain toward its perimeter. Reclamation design would aim to create conditions where runoff rates and volumes are similar to runoff reaching downstream surface water receptors for pre-Project site conditions. When the dry stack facility surface is fully revegetated and vegetation growth is dense and well established, runoff may no longer require suspended solids removal to meet water quality standards. Once suspended solids removal is no longer necessary, runoff would be discharged directly to the surrounding area and the collection ditches and ponds (both contact and non-contact) would be reclaimed and revegetated.

2.3.6 Monitoring of Tailings Management Site Non-Contact Area

The tailings management site reclamation material stockpile, perimeter ditch, and sediment pond would be inspected on a regular basis at a frequency determined necessary by regulatory authorities.

2.3.7 Maintenance of Tailings Management Site Non-Contact Area

Erosion features on the tailings management site reclamation material stockpile would be repaired. The surface would be reseeded and if necessary, treated with a temporary erosion control measure (e.g., erosion control mat). If sediment accumulates in the tailings management site reclamation material stockpile perimeter ditch and impedes flow, the sediment would be excavated and deposited on the tailings management site reclamation material stockpile. If sediment accumulates in the tailings management site reclamation material stockpile sedimentation pond to the point where it restricts flow through the pond or significantly limits the detention capacity of the pond, then the sediment would be excavated and deposited on the tailings management site reclamation material stockpile.

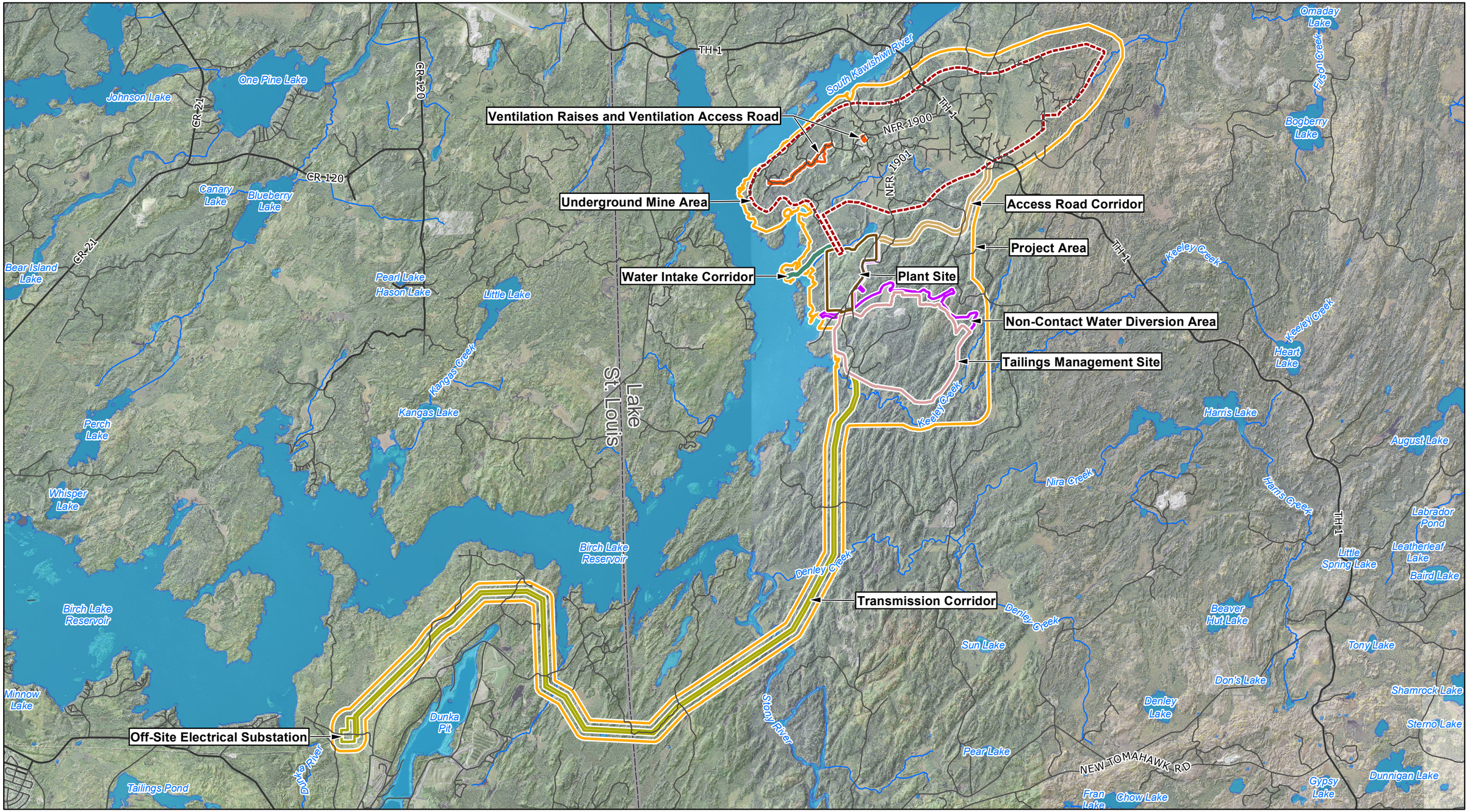
2.4 Underground Mine Area

Direct precipitation and stormwater would generate non-contact water on the ventilation raise sites and the ventilation raise access road. Non-contact water from these areas would be routed through appropriate discharge and would be managed to meet applicable surface water quality standards. BMPs would be implemented to meet erosion control and stormwater management requirements.

2.5 Corridors

The corridors include the access road, water intake corridor, and transmission corridor. Direct precipitation and stormwater would generate non-contact water within the corridors. Non-contact water from these areas would be directed through appropriate discharge controls and would be managed to meet applicable surface water quality standards. BMPs would be implemented to meet erosion control and stormwater management requirements.

FIGURES



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

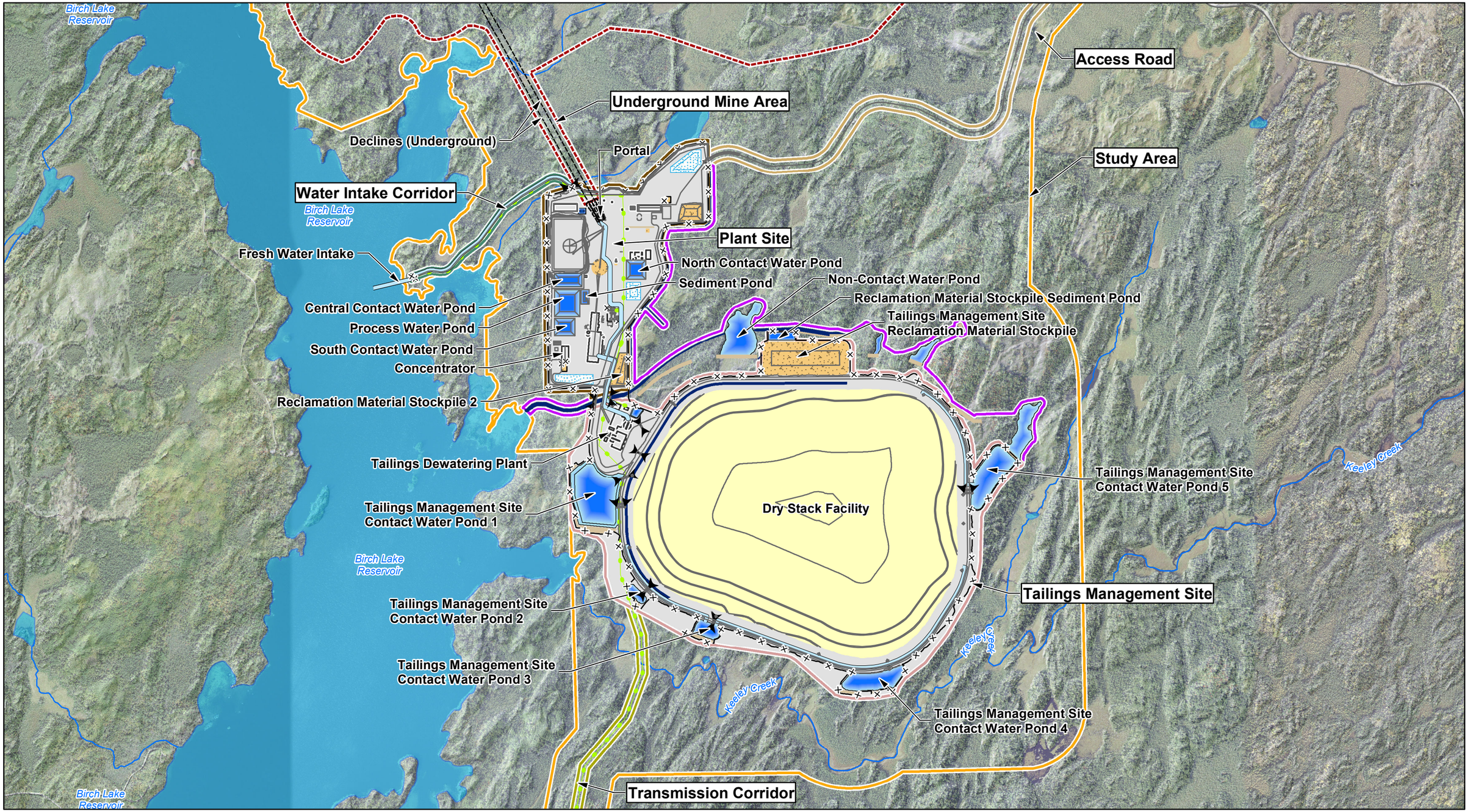
TWIN METALS MINNESOTA

FIGURE 1-1

GENERAL PROJECT LAYOUT

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Access Road

TWIN METALS MINNESOTA

N

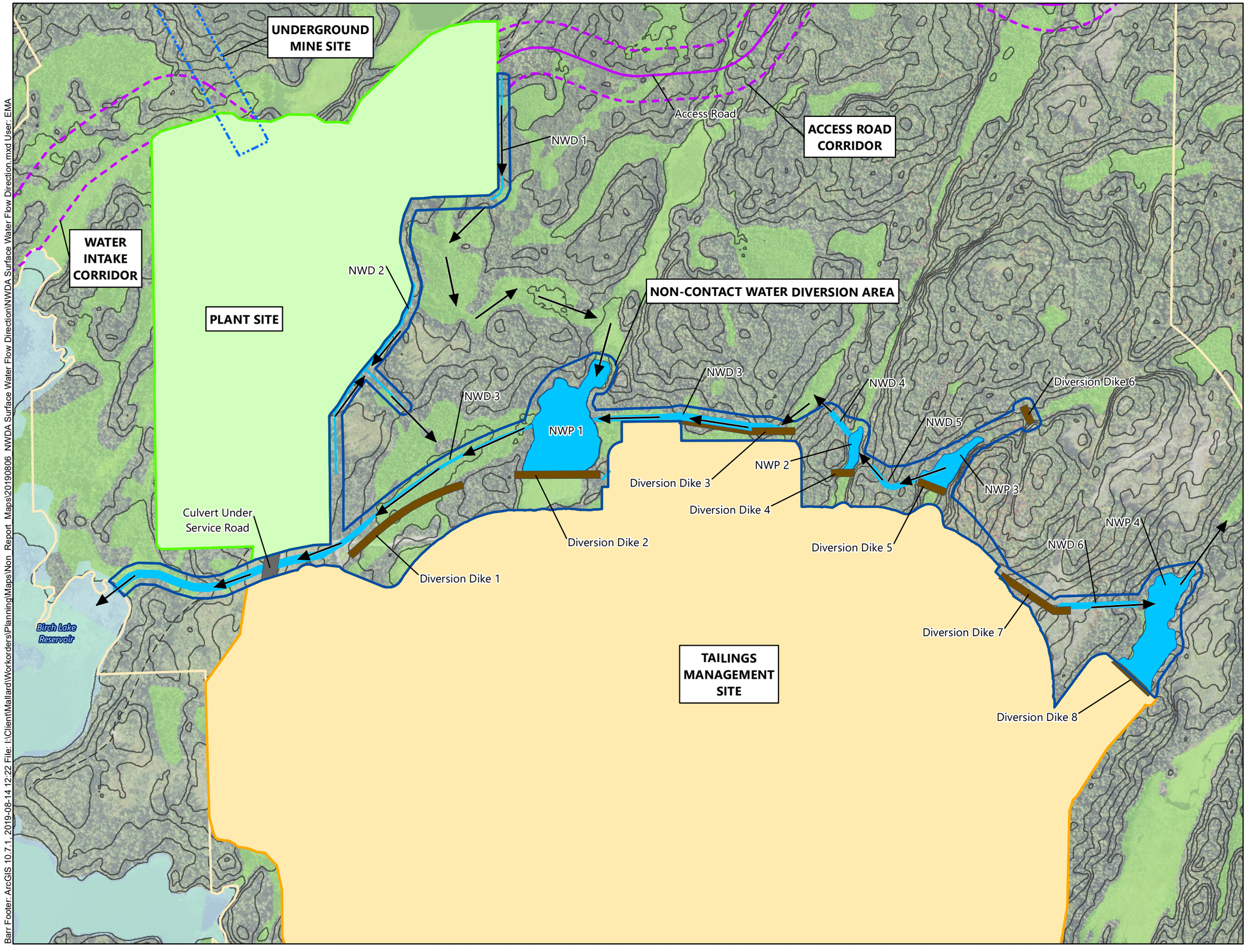
TWIN METALS MINNESOTA

FIGURE 1-2

PLANT SITE AND TAILINGS MANAGEMENT SITE OPERATIONS GENERAL ARRANGEMENT PLAN

Scale: 0 750 1,500 Feet

Date: SEPTEMBER 2019



- Project Area
- Underground Mine Area (Surface Projection)
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Access and Utility Corridor
- Road
- Dike
- Non-Contact Water Ditch (NWD)
- Non-Contact Water Pond (NWP)
- Service Road/Parking
- PWI Watercourse (MNDNR 2017)
- PWI Basin (MNDNR 2017)
- Wetlands
- Approximate Flow Direction
- Existing 10 ft Contour (Approx. 3m)
- USFS Roads (2013)

APPROVED 5:06 pm, Aug 14 2019

N

0 350 700 1,400
Feet

0 100 200 400
Meters

Figure 2-1

NON-CONTACT WATER DIVERSION AREA
SURFACE WATER FLOW DIRECTION
Twin Metals Minnesota
Lake and St. Louis Counties, MN

Barr Footer: ArcGIS 10.7.1, 2019-08-14 12:22 File: I:\Client\Mallard\Workorders\Planning\Maps\Non_Report_Maps\20190806_NWDA Surface Water Flow Direction\NWDA Surface Water Flow Direction.mxd User: EMA

APPENDIX D

CONTACT AND PROCESS WATER MANAGEMENT PLAN

CONTACT AND PROCESS WATER MANAGEMENT PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared by Twin Metals Minnesota LLC

Document No. TMM-EG-115-0002
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	N/A	1.0

REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SUMMARY 1
3.0 PROCESS WATER MANAGEMENT 1
3.1 UNDERGROUND MINE 3
3.2 PROCESS WATER POND 4
3.3 CONCENTRATOR 5
3.4 TAILINGS DEWATERING PLANT 6
3.5 DRY STACK FACILITY 7
3.6 PROCESS WATER MONITORING AND MANAGEMENT 8
3.6.1 Monitoring 8
3.6.2 Management 8
4.0 CONTACT WATER MANAGEMENT 9
4.1 UNDERGROUND MINE AREA 9
4.2 PLANT SITE 9
4.3 TAILINGS MANAGEMENT SITE 10
4.3.1 Tailings Dewatering Plant 10
4.3.2 Dry Stack Facility 11
4.3.3 Contact Water Ditches 13
4.3.4 Contact Water Ponds 14
4.4 CONTACT WATER MONITORING AND MANAGEMENT 14
4.4.1 Monitoring 15
4.4.2 Management 15

FIGURES

Located in Figures section at end of document:

Figure 2-1 General Project Layout
Figure 2-2 Plant Site and Tailings Management Site Operations General Arrangement

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

BMP	Best Management Practice
cm	centimeter
cm/sec	centimeters per second
e.g.	Latin phrase *exempli gratia* meaning “for example”
ft	foot
HDPE	high density polyethylene
i.e.	Latin phrase *id est* meaning “That is (to say)…”
in	inch
km	kilometers
LLDPE	linear low-density polyethylene
mm	millimeter
MPO	Mine Plan of Operations
Project	Twin Metals Minnesota Project
sec	second
TMM	Twin Metals Minnesota LLC

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process.

2.0 SUMMARY

The following Contact and Process Water Management Plan has been prepared as part of the Project's mine plan of operations (MPO) to inform management of contact and process waters. The Non-contact Water Management Plan has been prepared separately as part of the Project's MPO to inform management of non-contact water. The contents of this Contact and Process Water Management Plan include monitoring and management guidance for the following:

- Process water management for the:
  - underground mine;
  - process water pond;
  - concentrator; and
  - tailings dewatering plant.
- Contact water management for the:
  - plant site (contact water ponds); and
  - tailings management site.

The overall Project layout is presented in Figure 2-1 and a more detailed Project layout relating to contact water management features is presented in Figure 2-2. This Contact and Process Water Management Plan is intended to be a living document and would be updated as necessary during the Project's environmental review process. Updates would be submitted to the lead agency prior to construction.

3.0 PROCESS WATER MANAGEMENT

The Project would aim to maximize reuse of water in the process circuit while collecting and utilizing mine inflow and precipitation which would occur on contact

zones at both the plant site and tailings management site. Consumptive uses of water would be as follows:

- Residual water which would remain in the tailings filter cake placed on the dry stack facility;
- Residual water which would be consumed in the engineered tailings backfill;
- Residual water which would remain in the filtered concentrates shipped to market; and
- Evaporation which would occur from multiple sources.

These consumptive uses would be greater than make-up water expected from the reuse of process water, the use of mine flow, and the use of contact water. Therefore, the Project would expect intermittent use of make-up water from Birch Lake reservoir on an as-needed basis when the three other water sources would not meet process requirements from a quantity perspective.

The process water management strategy would be to prioritize water use for processing by the following list:

1. Reuse of process water;
2. Use of mine inflow (classified as process water as it would mix in the underground mine water dewatering system);
3. Use of contact water; and
4. Make-up water from Birch Lake reservoir.

As a part of the water management strategy, make-up water from Birch Lake reservoir and contact water from the contact water ponds would have raw water uses prioritized throughout the underground mine, plant site, and tailings management site. These prioritized water areas include, but are not limited to:

- Pressure filter cloth wash;
- Reagent make-up;
- Pump gland water; and
- Mine supply water.

The discussion presented in the contact water management section of this plan simplifies some aspects of process water management by saying that all make-up water from Birch Lake reservoir and all contact water from the contact water ponds would be routed to the process water pond, and that all process water demands would be fulfilled from the process water pond. This is accurate in terms of the water balance and the ultimate water destination. However, raw water priority uses would draw water directly from the Birch Lake reservoir source or from a contact water pond (when available) before that water would be routed to the process water pond. TMM anticipates that additional data collection and modeling would show the appropriation of this water as consistent with applicable standards.

3.1 Underground Mine

Management of water in the underground mine would play a key role in the overall Project water management strategy. Water management for the underground mine includes the following operations:

- The underground mine and underground mining activities;
- Underground mine dewatering;
- Engineered tailings backfill placement; and
- Ore conveyance.

Based on the current understanding of the overall water balance and the need for makeup water, the underground mine would have one dewatering system. While individual sources of water from the underground mine could initially be classified as contact water, mixing may occur with process water. Therefore, water removed from the underground mine (underground mine water) would be classified as process water.

Major inflows of water into the underground mine would include:

- Groundwater inflow into the mine (mine inflow);
- Process water used to transport the engineered tailings backfill;
- Process water used to flush the engineered tailings backfill lines; and
- Process water used as mine supply water for dust suppression and equipment requirements.

Groundwater would flow into the mine and would be collected in underground sumps prior to dewatering. During the process of engineered tailings backfill placement, process water would be used to pump the engineered tailings backfill as a thickened slurry to the empty stopes for disposal. The thickened slurry contains excess water which would also report to the underground sumps after the engineered tailings backfill has settled and solidified (engineered tailings backfill bleed water). engineered tailings backfill lines would be flushed with process water (engineered tailings backfill line flush water) which would also report to the underground sumps.

Mine supply water requirements would include dust suppression and equipment requirements such as drill water. Often, mine supply water needs would not be consumptive, meaning that while the water must be available during operations, excess water would report to the underground sumps and would be available for reuse.

Major outflows of water from the underground mine area would include:

- Pumping of underground mine water;

- Evaporation losses leaving the mine through the exhaust raises (ventilation losses); and
- Moisture contained in ore conveyed out of the mine (ore moisture).

Water in the underground mine would be collected in underground sumps before being pumped to the surface. Mine inflow, engineered tailings backfill bleed water, engineered tailings backfill line flush water, dust suppression water, and non-consumption mine equipment water would report to underground sumps. Using collection sumps, face pumps, skid pumps, tank pumping stations, and primary and secondary pump stations, water would be pumped from the underground mine. This stream would be the underground mine water. The underground mine water would be de-oiled on the surface and clarified in the single-lined sediment pond at the plant site. Clarified water may be reused in the underground mine as mine supply water. Excess clarified water from the sediment pond would report to the process water pond.

Underground roads, stockpiles, and muck piles would be watered for dust suppression and the ore conveyor system would be fitted with dust sprays, as necessary. Evaporation from these areas would result in water loss through the ventilation raises (ventilation losses). Water, in the form of ore moisture, would also leave the underground mine area when ore is conveyed to the surface and to the coarse ore stockpile.

3.2 Process Water Pond

The process water pond would be the central collection and distribution point for process water.

Major inflows to the process water pond would include:

- Underground mine water, described in Section 3.1;
- Separated water from the concentrator;
- Removed water from the tailings dewatering plant;
- Direct precipitation on the process water pond;
- Contact water from the plant site;
- Contact water from the tailings management site; and
- Make-up water from Birch Lake reservoir.

Underground mine water not reused as mine supply water would be directed to the process water pond from the sediment pond. Process water would ultimately be returned to the process water pond as a result of reducing water contents in various slurry streams through the use of thickeners and filter presses.

Stormwater runoff from the plant site (contact water) would report to the plant site contact water ponds. The plant site contact water ponds would be pumped to the

process water pond for use as process makeup water. Contact water collected from the tailings management site would eventually report to tailings management site contact water pond 1 where it would be pumped to the contact water tank at the tailings dewatering plant before being pumped to the process water pond through the return water pipeline.

Makeup water from Birch Lake reservoir would only be used when other process water pond inflows cannot meet the process water pond outflow demand.

Major outflows from the process water pond would include:

- Processing water supply, needed to increase the water content of ore slurries at various points within the process, including the comminution circuit, flotation circuit, tailings dewatering plant, and flushing requirements;
- Underground mine supply water; and
- Pond evaporation.

To aid the distribution of process water, the process water pond water would be pumped to a process water tank at the concentrator and a process water tank at the tailings dewatering plant. Each process water tank would act as the main distribution point for process water through their respective areas.

In the event that the underground mine supply water cannot be met by underground mine water (post oil / water separation and sediment removal) the demand would be met by water from the process water pond.

The process water pond liner system would consist of a 60 mil high density polyethylene (HDPE) or engineer-approved alternate geomembrane liner underlain by a geocomposite drainage layer, a 40 mil HDPE or engineer-approved alternate geomembrane liner, and a 1-foot (ft) (30.5 centimeter [cm]) layer of compacted material. The process water pond volume would be approximately 18,500,000 gallons (70,000 cubic meters). The process water pond would be sized to contain direct precipitation from the probable maximum precipitation, 24-hour storm event.

3.3 Concentrator

The concentrator is a subset of the process related to the recovery of target metals. A complete description of the concentrator (which includes the comminution circuit, flotation circuit, concentrate dewatering and storage, and reagent makeup) is included in the MPO.

Major inflows to the concentrator would include:

- Moisture contained in ore conveyed out of the mine (ore moisture); and
- Process water demand for the comminution and flotation circuits.

During the mining and ore conveying process, ore would be wetted down through dust control procedures. This water would enter the concentrator as ore moisture together with a minimal amount of naturally occurring moisture. The comminution and flotation circuits would process the ore as slurries. Makeup water from the process water pond would be added at various points in the process to increase the water content of the slurries for optimal processing.

Major outflows from the concentrator would include:

- Process water separated from the three concentrate products;
- Moisture contained in the three filtered concentrates; and
- Process water used to transport tailings slurry to the tailings dewatering plant.

After the copper, nickel, and gravity concentrates are separated from the tailings, thickeners and filters would be used to separate water from the concentrate products. The separated water would be returned to the process water pond for reuse. A small amount of moisture would remain in the concentrate products after filtering.

Process water would be used to transport the tailings slurry through the tailings supply line from the concentrator to the tailings thickener at the tailings dewatering plant.

The following operational controls would apply to facilities in the concentrator building for secondary containment:

- Containment areas, as necessary, would provide a minimum of 110 percent of the volume of the largest vessel in that area;
- Containment within the concentrator building would include sealed concrete floor slabs and walls to prevent leakage outside of the containment footprint;
- Floor drainage would lead into a sump from which water would be pumped to the process water pond; and
- Containment areas would have water stop or joint sealer in expansion, control, and construction joints.

3.4 Tailings Dewatering Plant

The tailings dewatering plant would process the tailings produced from the concentrator to create filtered tailings cake for placement on the dry stack facility and engineered tailings backfill for placement in mined out stopes. The tailings dewatering plant would consist of the tailings thickener, filter plant, backfill plant, and the filter cake storage and loadout building.

Major inflows of water into the tailings dewatering plant would include:

- Process water used to transport the tailings to the tailings dewatering plant as a slurry;
- Contact water from the tailings management site to meet filter cloth wash water needs; and
- Process water from the process water pond to meet binder and thickener dilution requirements.

Tailings from the concentrator would be pumped to the tailings dewatering plant where a tailings thickener would increase the percent solids content of the slurry by removing process water. The thickened slurry would be pumped to the filter plant where filter presses would further dewater the tailings to produce a tailings filter cake. In an operating scenario when engineered tailings backfill would be produced for placement in mined out stopes, a portion of the thickened tailings would bypass the filter plant and would be pumped to the backfill plant. At the backfill plant, the thickened slurry would be combined with tailings filter cake and a binder to produce an engineered tailings backfill for placement in mined out stopes.

Contact water from the tailings management site contact water ponds would be utilized for filter plant cloth washes and for mixing with the tailings to form the engineered tailings backfill. Process water from the process water pond would be utilized as necessary for makeup water in the tailings dewatering plant in the event that contact water is not available from the tailings management site contact water ponds.

Major outflows of water from the tailings dewatering plant include the following:

- Process water used to transport the engineered tailings backfill;
- Contact water pumped to the process water pond;
- Process water contained as moisture in the tailings filter cake; and
- Excess process water returned to the process water pond.

Process water would be removed from the tailings in the tailings thickener and filter plant and returned to the process water pond for reuse. Process water contained in the engineered tailings backfill would be transported underground for placement in mined out stopes. This contains contact water added to the binder prior to mixing with the tailings to form the engineered tailings backfill. After filtering, some water would remain as moisture in the filtered tailings cake which gets transported to the dry stack facility for placement.

The tailings thickener would be a steel supported above-ground structure. Should a loss of containment occur, slurry would flow to an emergency pond located adjacent to the tailings thickener.

3.5 Dry Stack Facility

The tailings filter cake would have free water removed before being loaded from the filter cake storage and loadout building into a haul trucks for transport to the dry stack facility for permanent placement. No process water would be required for the dry stack facility. Precipitation which falls on the dry stack facility would be classified as contact water. Contact water management for the dry stack facility is discussed in Section 4.3.2.

3.6 Process Water Monitoring and Management

A monitoring plan would be developed for the Project. The following section outlines high-level monitoring and management plans for the process water system.

3.6.1 Monitoring

Inspection of the underground mine water system would be performed monthly and following planned or unplanned maintenance.

Pond leak detection ports at the process water pond would be monitored weekly. The process water pond freeboard would be monitored continuously and the daily average flow rate of water from the process water pond would be monitored from the plant control system or other appropriate methods.

Inspections would be performed on the concentrator and tailings dewatering plant on a regular basis at a frequency determined necessary by regulatory authorities. Operators would report if leaks are discovered. Secondary containments would be inspected and material buildup would be removed on a regular basis as part of routine maintenance practices. Operating personnel would perform routine inspections at a frequency determined necessary by regulatory authorities to ensure that the floor drainage is effectively maintained and that the sumps and pumps are fully operational.

3.6.2 Management

Observations of potential integrity issues to the underground mine water system would be reviewed with the underground department and corrective actions would be taken pursuant to staff recommendations as necessary.

To maintain storage volume, a portable slurry pump would be used to periodically sluice sediment from the sediment pond to the tailings thickener or other appropriate location. If the process water pond is at risk of exceeding a maximum operational volume threshold due to the inflow of underground mine water, excess water would be directed to the concentrator where it would be used for processing makeup water.

Adequate freeboard would be maintained in the process water pond by controlling inflow from Birch Lake reservoir. If the process water pond is at risk of exceeding a maximum operational volume threshold based on freeboard requirements, excess

water would be directed to the process circuit where it would be included in the tailings stream sent to the tailings dewatering plant. In upset conditions, excess process water at the tailings dewatering plant could be routed to the tailings management site contact water pond 1. This pond would be required to maintain sufficient capacity for the 100-year spring snow melt event but would have excess capacity during other times of the year.

Observations of potential integrity issues to containment controls within the concentrator and tailings dewatering plant would be reviewed with the processing department and corrective actions (if any) would be taken pursuant to staff recommendations.

4.0 CONTACT WATER MANAGEMENT

4.1 Underground Mine Area

Surface components of the underground mine area would be the three ventilation raise sites and the ventilation access road. These surface components would be separated from the plant site and the handling of ore and tailings. Therefore, there would not be a contact water management area associated with the underground mine surface facilities.

4.2 Plant Site

The plant site would be divided into non-contact water areas and water contact areas. The contact water areas at the plant site would be associated with ore flow from the mine and would include the portals, the mine services buildings, the temporary rock storage facility, and the connecting internal site roads. The contact water area of the plant site would be graded to collect stormwater into three contact water ponds (north, central, and south). These ponds are shown on Figure 2-2.

The plant site contact water ponds would be sized to contain a 100-year, 24-hour storm event. The contact water ponds would be lined with a 60 mil HPDE or engineer-approved alternate geomembrane liner over a 1-ft (300-millimeter [mm]) thick, low-permeability, compacted soil liner; the soil layer would be compacted to meet maximum hydraulic conductivity requirements of not more than 1×10^{-6} centimeters per second (cm/sec). Stormwater from the surface near the mine portals would flow by gravity to the north contact water pond before being pumped to the central contact water pond. The catchment area for the central contact water pond would include the temporary rock storage facility. The central and south contact water ponds would be pumped into the process water pond and used as process water. The contact water ponds would be normally kept at a minimal level and water would be pumped to the process water pond.

The temporary rock storage facility would be lined with an 80 mil linear low-density polyethylene (LLDPE) or engineer-approved alternate geomembrane liner, overlain

by 12 inches (in) (300 mm) of compacted low permeability soil and 12 in (300 mm) of sand. All surface runoff stormwater from the temporary rock storage facility would be collected in a perimeter ditch designed for a 10-year, 24-hour storm event and conveyed to the central contact water pond. The coarse gradation of the ore stockpiles placed on the temporary rock storage facility would provide good drainage to limit build-up of pore-pressure. The rock and underlying sand protection layer would have a sufficiently high permeability to drain towards the perimeter ditches.

To facilitate separation of contact stormwater water from non-contact stormwater, the plant site roads would be divided into contact roads and non-contact roads. Contact roads would be confined to use by vehicles used for mine operations and non-contact roads would be for vehicles which are not directly related to production or maintenance. Any vehicle which uses a contact road would go through the tire wash before exiting back to the non-contact roads. Drainage from contact roads would be routed to the contact water ponds.

Snowmelt would also be managed as contact stormwater. There would be three designated snow storage areas. These snow storage areas have been designed to accommodate a snow water equivalent of between 7.3 to 11.9 in (185 to 301 mm).

4.3 Tailings Management Site

4.3.1 Tailings Dewatering Plant

The tailings management site would be classified as a contact zone with three exceptions: the reclamation material stockpile; portions of exposed liner prior to tailings filter cake being placed; and concurrently reclaimed portions of the dry stack facility which have the cover installed. Tailings management site contact water systems would collect stormwater in the contact zone and route it to contact water ponds. Water collected in the contact water ponds would be used for dust control at the tailings management site with excess water pumped to the process water pond at the plant site for use as process water.

Contact water management is discussed as related to the tailings dewatering plant or the dry stack facility. At the tailings dewatering plant, surfaces would be graded so stormwater would flow to the south and into the tailings management site contact water pond 1. The dry stack facility contact water management system would include a liner system (including over-liner and under-liner drains), contact water ditch, seepage cutoff wall with grout curtain (groundwater cutoff wall), and contact water ponds.

Tailings filter cake would be transported by haul truck from the filter cake storage and loadout building to the dry stack facility. The tailings filter cake would be placed and compacted over a lined foundation with interior base drains and perimeter ditches to collect precipitation as draindown or runoff that has been in contact with the tailings

(contact water). Project water management components to which contact water from the dry stack facility report are described below.

4.3.2 Dry Stack Facility

The dry stack facility would be constructed as a compacted fill embankment slope with no internal pond. Stormwater from the exposed tailings would be shed to the outer edges of the dry stack facility. The dry stack facility crest and embankments slopes would be provided with swales, ditches, and erosion protection in the ditches to prevent formation of gullies and uncontrolled erosion. The dry stack facility swales and ditches that direct water off the dry stack facility would discharge into the contact water ditch that extends around the full perimeter of the dry stack facility.

Until the dry stack facility is covered during concurrent reclamation, some of the precipitation that falls on the tailings may infiltrate and percolate vertically through the tailings. The infiltrating portion of precipitation which would infiltrate the tailings and seep through the tailings would be intercepted by the dry stack facility liner system. The liner system includes an over-liner drain, a geomembrane liner, and an under-liner drain.

The first step in construction of the liner system would be to install a network of gravel under-liner drains along the natural drainage courses (i.e. low points in the topography to which water would naturally drain) that cross the dry stack facility footprint. The gravel drains would be created by excavating ditches into the foundation soils at the base of these drainage courses. The excavated ditches would be backfilled with gravel. The under-liner drain would discharge to the contact water ditch. The purpose of the under-liner drains would be to limit the phreatic head in the foundation soils under the geomembrane liner to prevent uplift of the liner prior to tailings placement. The under-liner drain is also considered a Best Management Practice (BMP) and would also be a secondary control to capture potential seepage through the dry stack facility liner. Seepage through the membrane to the under-liner drain is expected to be insignificant due the design of the dry stack facility, quality assurance / quality control during construction, and documented performance history of other dry stack facilities. Seepage from the dry stack facility would be further controlled by the construction of the groundwater cutoff wall. The potential magnitude of seepage has not yet been quantified and would be addressed as a future scope of work.

The dry stack facility geomembrane liner would be a 60-mil LLDPE or engineer-approved alternate geomembrane liner. The LLDPE liner would be installed over the prepared foundation and over the network of gravel under-liner drains. The liner would be protected by a minimum 1 ft (0.3 m) -thick layer of compacted tailings which would be pushed into place by dozers and compacted prior to truck traffic being allowed over the liner.

The intercepted precipitation that would infiltrate through the tailings – referred to as draindown – would be intercepted by the liner and collected by a network of gravel finger drains constructed above the liner extending across the dry stack facility footprint in the same location as the under-liner drains (i.e. natural drainage courses). A gravel blanket drain would also be constructed around the full perimeter of the dry stack facility at the toe, having a width of 160 ft (50 m). The over-liner drains - both finger drains and blanket toe drain - would discharge to the perimeter contact water ditch. The potential magnitude of draindown has not yet been quantified and would be addressed as a future scope of work.

At the dry stack facility, stormwater, seepage from the under-liner drain, and draindown from the over-liner drain would all be captured in contact water ditches installed around the perimeter toe of the dry stack facility. Compacting the tailings after placement would increase the amount of runoff and decrease the amount of draindown compared to non-compacted tailings. The crest of the dry stack facility would be graded to shed stormwater to the perimeter of the dry stack facility, limiting ponding of precipitation

The contact water ditch would route the water to the closest contact water pond. For greater portions of the perimeter length, the contact water ditch would be excavated into bedrock. The contact water ditch side slopes and base of the ditch would be a compacted low permeability soil. In locations where the ditches would be excavated into soil, the side slopes and base of the ditch would be protected against erosion with grass vegetation or armoring with riprap or alternate permanent erosion control measures.

The groundwater cutoff wall would be on the outer edge of the contact water ditches beneath the perimeter haul road to encompass the dry stack facility and contact water ditch. The groundwater cutoff wall would include a seepage cutoff trench with a grout curtain installed as necessary depending on bedrock condition. The seepage cutoff trench would consist of an excavated trench from ground surface to the top of bedrock that would be backfilled with compacted, low permeability soil. In locations where the bedrock has been identified as fractured, faulted, or weathered, a grout curtain would be installed, consisting of pressure grouted boreholes to a depth that would be determined based on geotechnical investigations. The seepage cutoff trench and grout curtain would serve two purposes: reduce flow of regional groundwater from outside the dry stack facility footprint into the foundation soils below the dry stack facility, minimizing the need to manage additional non-contact water volumes; and restrict the flow of any contact water out of the contact water ditch and dry stack facility footprint.

Five permanent tailings management site contact water ponds would be constructed in addition to two interim contact water ponds that would be installed to manage water during stage 1 and stage 2 of the dry stack facility before the facility is at the full footprint. The tailings management site contact water ponds would be sized to

contain the 100-year, 24-hour storm events, for their respective catchment areas. In addition, the collective storage capacity of the tailings management site contact water ponds for the dry stack facility during operation would be sized to meet the runoff requirements from a 100-year snowpack. The tailings management site contact water ponds would be single lined with the same liner design as the plant site contact water ponds. The dry stack facility contact water management system (liner, over-liner and under-liner drains, contact water ditch, seepage cutoff wall with grout curtain, and contact water pond) would be constructed concurrently with the dry stack facility stages. Two interim contact water ponds would be constructed along the stage 1 and stage 2 interim toes of the dry stack facility. Stage 1 of the dry stack facility would include construction of tailings management site contact water pond 1, tailings management site contact water pond 2, and interim contact water pond 1. Stage 2 would include construction of tailings management site contact water pond 3 and interim contact water pond 2. Stage 3 would include construction of tailings management site contact water pond 4 and tailings management site contact water pond 5.

The dry stack facility would be concurrently reclaimed during the operation phase. As portions of the slope and crest of the dry stack facility are constructed, the completed surfaces would be graded and covered to promote runoff and inhibit infiltration. The cover would consist of at least 2 ft (60 cm) of cover soil underlain by a hydraulic barrier. Cover soil would be sourced from the reclamation material stockpile and seeded to establish grasslands.

Portions of the dry stack facility that have been concurrently reclaimed would no longer generate contact water, and stormwater runoff would be collected in a temporary non-contact water ditch and managed as non-contact water, as described in the Non-contact Water Management.

4.3.3 Contact Water Ditches

The perimeter contact water ditches would collect surface water runoff that has been in contact with tailings as well as draindown collected and discharged by the base drains and toe drain. The contact water ditches would discharge to the contact water ponds. The contact water ditches would be sized for the peak flow from a 100-year, 24-hour rainfall event. For greater portions of the perimeter length, the ditches would be excavated into bedrock. In locations where the ditches are excavated into soil, the side slopes and base of the ditch would be protected against erosion with grass vegetation or armoring with riprap or alternate permanent erosion control measures, depending on the estimated peak flow rate and imposed fluid shear stress.

On the outer edge of the contact water ditch (side of contact water ditch opposite the tailings), a compacted soil seepage cutoff wall through the overburden soil would be installed with the additional construction of a grout curtain through zones of fractured or weathered upper bedrock as required. This cutoff wall would serve as a secondary

form of containment when routing the contact water through the contact water ditches to the contact water ponds.

4.3.4 Contact Water Ponds

Major inflows for each contact water pond would include runoff from their corresponding catchment area (precipitation and snowmelt), drain down collected by the base drains and discharged to the contact water ditches, and direct precipitation and snowmelt on the contact water pond surfaces. The tailings management site contact water ponds would be designed to allow for the transfer of contact water to the tailings management site contact water pond 1 either through piping or through the pumping of water to contact water ditch divide points. In order to get from the east to the west side of the dry stack facility, the water could end up in multiple ponds and could be pumped multiple times. Transfers from one tailings management site contact water pond to another would include:

- Tailings management site contact water pond 5 would transfer water to tailings management site contact water pond 4;
- Tailings management site contact water pond 4 and tailings management site interim contact water pond 2 would transfer water to tailings management site contact water pond 3;
- Tailings management site contact water pond 3 and tailings management site interim contact water pond 1 would transfer water to tailings management site contact water pond 2; and
- Tailings management site contact water pond 2 would transfer water to tailings management site contact water pond 1.

Major outflows from the contact water ponds would include, in order of magnitude: processing water requirements (i.e. transfer to the process water pond), evaporation from the pond, and local dry stack facility uses (e.g., dust suppression). Water for processing would only be withdrawn from tailings management site contact water pond 1. Water would be pumped from tailings management site contact water pond 1 to the contact water tank at the tailings dewatering plant.

During periods of high inflow (e.g. spring snowmelt) there would potentially be insufficient room in tailings management site contact water pond 1 to pump all of the water out of the smaller contact water ponds. During these design inflow periods, some water may need to be held temporarily in the smaller ponds until the water level of tailings management site contact water pond 1 is sufficiently drawn down through process needs, at which point the smaller ponds would be fully pumped out.

4.4 Contact Water Monitoring and Management

A monitoring plan would be developed for the Project. The following section outlines high-level monitoring and management plans for the contact water system.

4.4.1 Monitoring

Dry Stack Facility Slope and Base Drains

The dry stack facility slope would be monitored in accordance with the mine permit. Constructed portions of the dry stack facility would be monitored on a regular basis at a frequency determined by regulators for sloped stability, erosion, and general site safety. Visual inspections of the discharge outlets of the base drains would be performed to ensure that the drains are in working order and are not obstructed at the outlets. Changes in the condition of the drain or observed flow rates would be noted and dry stack facility operations staff would be notified.

Additionally, sediment discharge prevention BMPs would be inspected on a weekly basis to document efficacy and physical condition.

Contact Water Ditch

Visual inspections of the contact water ditches would be performed to ensure that the facilities are in good operating condition (e.g. no major sediment accumulation or other obstructions). More thorough inspections of the contact water ditches would be performed to investigate for erosion and/or sediment deposition following major precipitation events.

Culverts would also be monitored on a weekly basis to ensure their inlet, outlet, and full cross sections remain free of obstructions to flow. Culverts would also be inspected on a bi-annual basis to confirm their physical integrity, documenting any deflections, buckling, erosion, and abrasion.

Contact Water Ponds

Inspection of the operating depth and freeboard within the contact water ponds would be performed daily as well as during and after major precipitation events. Water levels would normally be kept at a minimal level as informed by the water balance. Sediment accumulation would be monitored on a bi-annual basis. These inspections would also monitor for the general condition of the interior and exterior side slopes. Inspection of the pumps and pipelines between the contact water ponds would be performed monthly and following planned or unplanned maintenance.

During sediment removal activities, the excavated sediment would be inspected for gravel which may be part of the protective layer of granular material. After completion of sediment removal activities, the protective layer of granular material would be inspected to identify any major deficiencies.

4.4.2 Management

Dry Stack Facility Slope and Base Drains

The dry stack facility would be monitored and managed in accordance with TMM's mine permit. BMPs would be reconfigured and / or replaced as required.

Contact Water Ditch

When sediment deposits in the contact water ditch reach levels which could adversely affect conveyance capacity, the sediments would be excavated and deposited onto the dry stack facility to restore conveyance capacity. If the base or side slopes of the contact water ditch experience erosion after a major runoff event, the ditch profile would be restored and the ditch would be reseeded with vegetation or riprap armoring would be placed/replaced.

Culverts would be flushed if required. If physical integrity issues are identified, these would be discussed with the engineer of record to determine the best corrective actions.

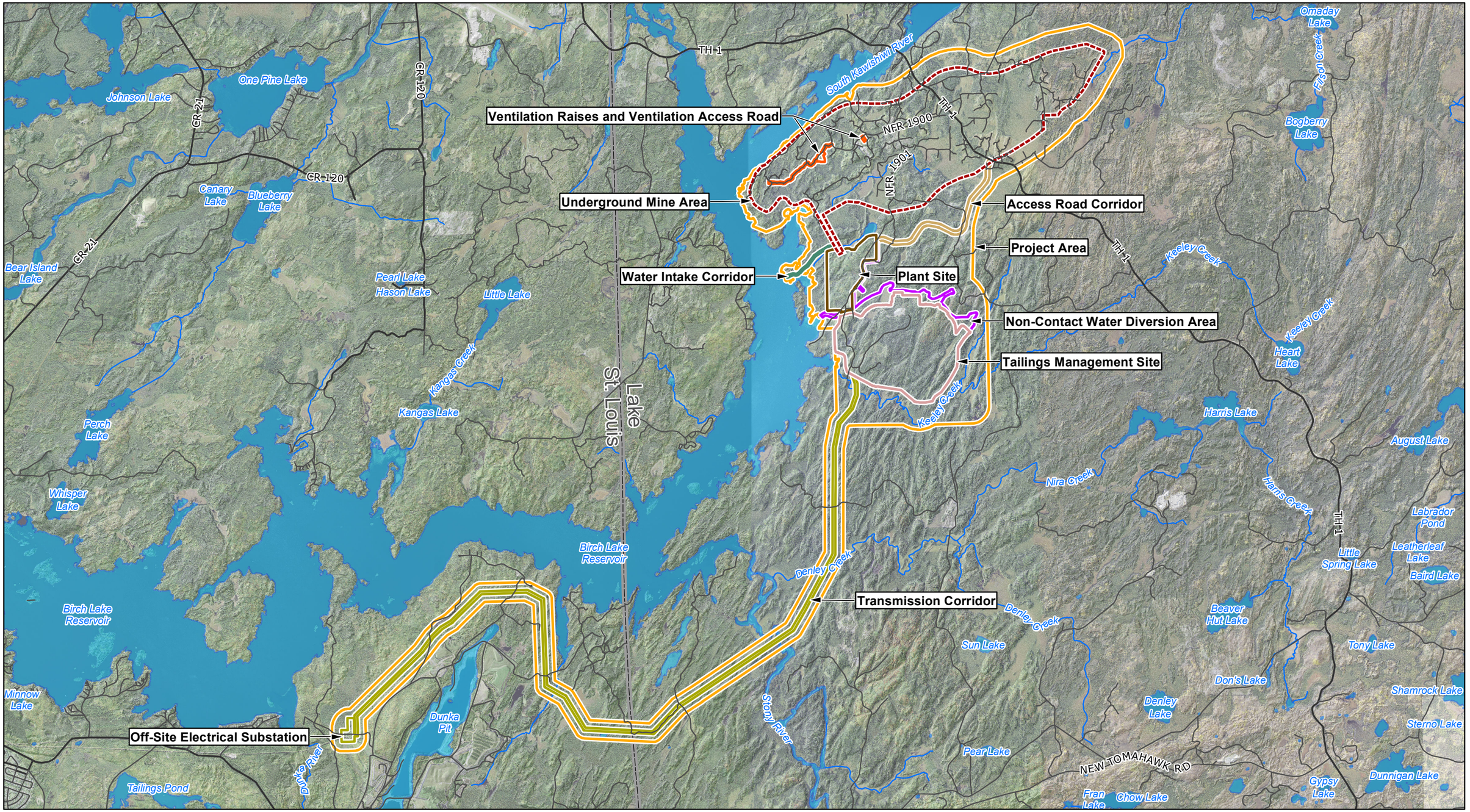
Contact Water Ponds

Sediment from the contact water ponds would be removed when it exceeds a depth of one meter. The excavated sediment would be deposited on the dry stack facility. Erosion, settlement, or cracking of the pond berms observed during inspections would be immediately repaired, reshaping the side slopes as required. Where the protective layer of granular material has been removed or displaced, it would be restored. The portable pumps would be removed each winter and then repositioned every spring.

To ensure that capacity for the design storm event is maintained, excess standing water would be routinely evacuated from the smaller contact water ponds during the summer, provided there is sufficient storage capacity in the process water pond and tailings management site contact water pond 1.

In the event of that wet spots are observed on the downstream slope and toe of the dike, these would be immediately reported to the primary permitting agency and the engineer of record for assessment and issuance of recommendations for corrective activities.

FIGURES



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- County Boundary
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor

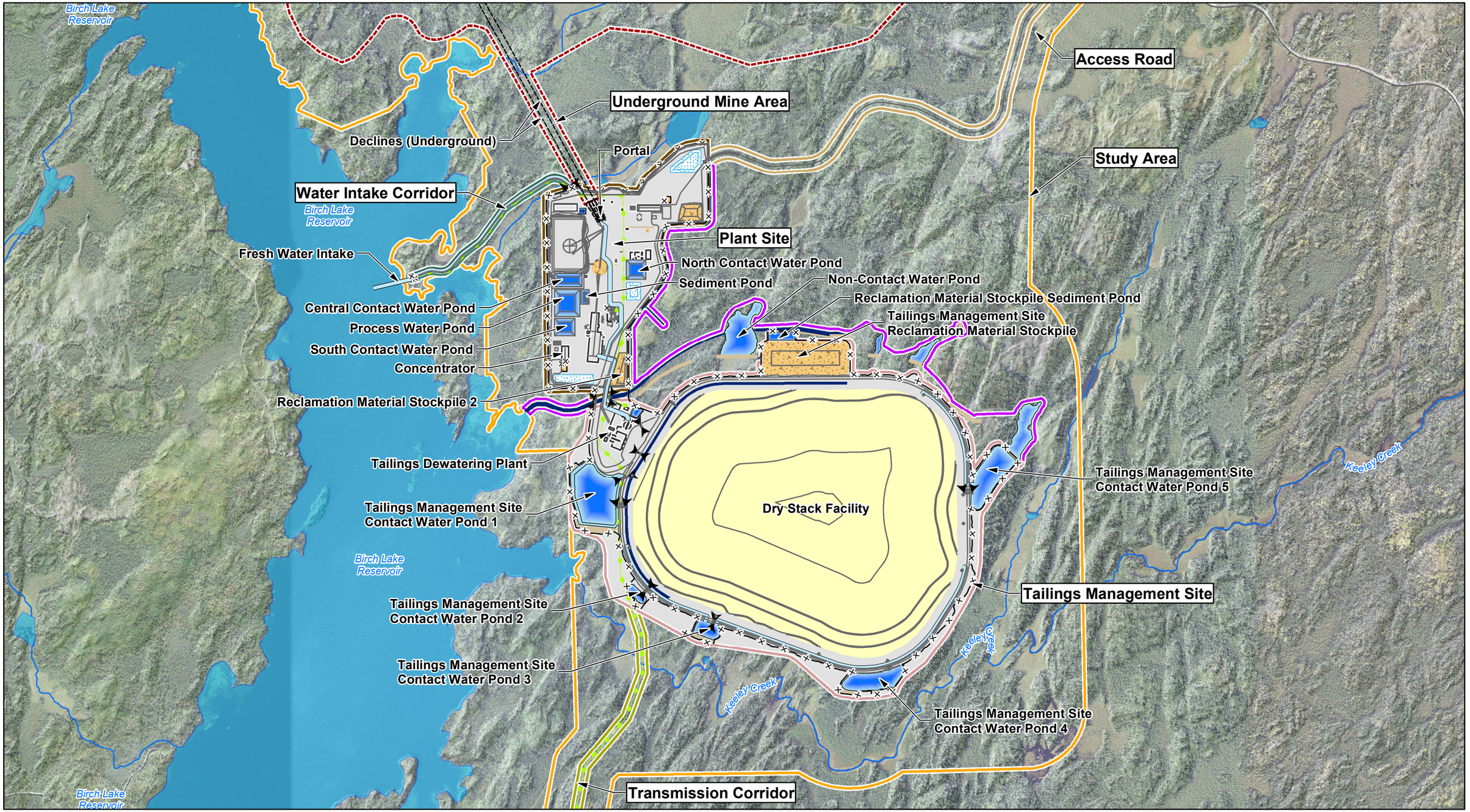
TWIN METALS MINNESOTA

FIGURE 2-1

GENERAL PROJECT LAYOUT

Scale: 0 2,500 5,000 Feet

Date: SEPTEMBER 2019



NOTES:

1. Base air photo from the U.S. Department of Agriculture Farm Service Agency, Aerial Photography Field Office.
2. Hydrographic data from Minnesota Department of Natural Resources.
3. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Facility
- Decline
- Piping
- Culvert
- Electrical Transmission Line
- Fence
- Vegetative Screen
- River/Stream
- Lake/Pond
- Project Area
- Underground Mine Area
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Access Road

TWIN METALS MINNESOTA

FIGURE 2-2

PLANT SITE AND TAILINGS MANAGEMENT SITE OPERATIONS GENERAL ARRANGEMENT PLAN

Scale: 0 750 1,500 Feet

Date: SEPTEMBER 2019

N

APPENDIX E

TRANSPORTATION PLAN

TRANSPORTATION PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
Prepared by SRK Consulting (U.S.), Inc.

Document No. TMM-ES-115-0006
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	N/A	1.0

REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SUMMARY 1
3.0 TRANSPORTATION PLAN 2
3.1 KEY REGIONAL TRANSPORTATION CORRIDORS 2
3.1.1 Highway (HWY) 1 – Principal Arterial Road 2
3.1.2 County Road (CR) 21 and CR 120 – Principal Arterial Road to Minor Arterial Road 2
3.1.3 New Tomahawk Road – Minor Arterial Road 2
3.1.4 National Forest Road (NFR) 1900 – Collector Road 2
3.1.5 NFR 1901 – Collector Road 2
3.2 SITE ACCESS 3
3.2.1 Ventilation Raise Sites 3
3.2.2 Water Intake Corridor 3
3.2.3 Transmission Corridor 3
3.3 ROAD MAINTENANCE PLAN 3
3.4 TRANSPORT OF CONSTRUCTION MATERIALS 4
3.5 TRANSPORT OF EQUIPMENT 4
3.6 CHEMICAL REAGENTS 5
3.7 TRANSPORT OF FUEL 5
3.8 TRANSPORT OF EXPLOSIVES 6
3.9 TRANSPORT OF WORK FORCE 6
3.10 TRANSPORTATION VEHICLES 6
4.0 PRODUCT SHIPMENTS 7
5.0 DELIVERY/CONTRACTOR TRUCK TRIPS 7
6.0 HAZARDOUS MATERIALS AND SOLID WASTE 7
6.1 HAZARDOUS MATERIALS 7
6.1.1 Transportation of Hazardous Materials 7
6.1.2 Blasting Agents 8
6.1.3 Acids 8

7.0 SOLID WASTE 8
8.0 PROJECT CLOSURE 8
9.0 POTENTIAL TRANSPORTATION-RELATED IMPACTS 9
10.0 OPERATING PRACTICES 9
10.1 OPERATING PRACTICE #1 10
10.2 OPERATING PRACTICE #2 10
10.3 OPERATING PRACTICE #3 10
10.4 OPERATING PRACTICE #4 10
10.5 OPERATING PRACTICE #5 10
10.6 OPERATING PRACTICE #6 11
10.7 OPERATING PRACTICE #7 11
10.8 OPERATING PRACTICE #8 11
11.0 REFERENCES 12

TABLES

Located in Tables section at end of document:

Table 3-1: Bulk Processing Reagents
Table 3-2: Primary Fuels and Lubricants
Table 3-3: Anticipated Emulsion Quantities
Table 3-4: Vehicle Classifications
Table 9-1: Traffic Forecasts

FIGURES

Located in Figures section at end of document:

Figure 3-1 Key Transportation Corridors

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

§	section
AADT	average annual daily traffic
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
CR	county road
e.g.	abbreviation for the Latin phrase *exempli gratia* meaning "for example"
etc.	abbreviation for the Latin phrase *et cetera* meaning "and other similar things" or "and so forth"
FHWA	Federal Highway Administration
GVWR	gross vehicle weight rating
HWY	highway
km	kilometer
L	liter
LOS	level of service
MnDOT	Minnesota Department of Transportation
NFR	National Forest Road
Project	Twin Metals Minnesota Project
st	short ton
TMM	Twin Metals Minnesota LLC
USFS	United States Forest Service

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information to federal and state agencies for the environmental review and permitting process. TMM retained SRK Consulting (U.S.), Inc. to assist with this Transportation Plan.

2.0 SUMMARY

This Transportation Plan addresses traffic and road use associated with the proposed Project. This document:

- Describes existing roads;
- Identifies site access;
- Identifies the parties responsible for road maintenance; and
- Estimates traffic levels associated with construction, operation, and closure of the Project.

The Project area includes portions of Saint Louis County and Lake County, Minnesota, and would be accessed using existing county, state, and federal (e.g., U.S. Forest Service or USFS) roads as well as newly constructed roads specific to operations. In accordance with the Bureau of Land Management (BLM) recommended operating procedures (BLM, 2012), TMM is proposing access routes which are the most direct and safe with the least amount of new surface disturbance.

TMM conducted a transportation analysis of the Project area to analyze existing and future traffic conditions associated with the Project. Relevant information developed has been incorporated into this Transportation Plan.

3.0 TRANSPORTATION PLAN

3.1 Key Regional Transportation Corridors

Principal arterial roads, such as federal interstates and state highways, accommodate high traffic volumes and have limited access. Minor arterial roads include county roads that connect population centers with principal arterial roads. Collector roads include county and USFS roads that provide primary access to large blocks of land and are generally two lanes wide.

Local and resource roads include USFS and private roads that link areas with low traffic volumes to higher classification roads. Local roads connect to collector roads and serve a smaller area than collector roads and may be one or two lanes with lower traffic volumes. Resource roads are USFS roads that provide point access, connecting to local or collector roads, and are generally single lanes.

Figure 3-1, located in the figures section at the end of this report, depicts the identified key regional transportation corridors which are further described below.

3.1.1 Highway (HWY) 1 – Principal Arterial Road

The section of HWY 1 (also known as Trunk Highway 1) between the Project and Ely, Minnesota is a paved two-lane roadway with an average annual daily traffic (AADT) volume of 1,150 daily trips. HWY 1 to southeast of the Project is also a paved two-lane roadway with an AADT volume ranging between 375 to 930 daily trips.

3.1.2 County Road (CR) 21 and CR 120 – Principal Arterial Road to Minor Arterial Road

The section of Saint Louis CR 21 and CR 120 (Virginia Ely Road) between Babbitt, Minnesota and HWY 1 is a paved, two-lane roadway with an AADT volume ranging from 360 daily trips on CR 120 to 1,400 daily trips on CR 21. East of Salo Road toward the City of Babbitt, CR 21 has an existing AADT volume of 2,000 daily trips.

3.1.3 New Tomahawk Road – Minor Arterial Road

The New Tomahawk Road, located south of the Project, is a rural unpaved, two-lane roadway with an AADT of 130 daily trips.

3.1.4 National Forest Road (NFR) 1900 – Collector Road

NFR 1900 is currently an unpaved rural roadway which intersects HWY 1 north of the Project. No AADT information is available for this road.

3.1.5 NFR 1901 – Collector Road

NFR 1901 is currently an unpaved rural roadway located north and west of the Project. No AADT information is available for this road.

3.2 Site Access

Initial construction access to the Project area would be from NFR 1900 and NFR 1901, via TH 1. Once constructed, the access road to the Project area would extend from TH 1 to the plant site, as illustrated in Figure 3-1. The access road would be a two-lane gravel road with 14 foot (4.3 meter) -wide lanes. Ditches would be provided for stormwater runoff control, and culverts would be sized to accommodate a 100-year, 24-hour storm event. A staffed gatehouse would be located on the northern edge of the plant site to provide controlled access to the Project from the access road.

3.2.1 Ventilation Raise Sites

Access to the ventilation raise sites would be from NFR 1900 and existing drill roads (Figure 3-1). These roads would be extended or upgraded to one-lane gravel roads sufficient for construction and propane delivery truck access.

3.2.2 Water Intake Corridor

Access to the water intake corridor would originate from the plant site. The access road within the water intake corridor would be a gravel, single-lane access road which would end at the water intake facility, as illustrated on Figure 3-1.

3.2.3 Transmission Corridor

The transmission corridor would be accessed by a two-track, unpaved maintenance road. The maintenance road would originate at the plant site electrical substation and would terminate at an off-site electrical substation, as illustrated on Figure 3-1.

3.3 Road Maintenance Plan

Maintenance of access roads would be conducted in cooperation with the responsible government entity (e.g., USFS, Saint Louis County, and/or Lake County). A cooperative maintenance agreement would be developed between TMM and the USFS defining the responsibilities and services to be provided. A similar agreement would be developed with each county to ensure maintenance of the access road between TH 1 and the Project. TMM would provide supplemental resources, as required, to support government agencies in maintaining the roads and ensuring safe access to and from the Project.

Roads would be maintained as-required. Daily inspections of the access road would be made during work-days by site personnel. If the roads are inactive for a period of time, they would be inspected prior to use. Control, warning, and directional traffic signs

would be installed and used as necessary. Speed limits, directional traffic signs, or control signs would be posted at all entrances to the access road and Project area.

TMM maintenance and snow removal equipment (for maintenance work and snow removal on Project roads) would include, but not be limited to: graders, loaders, and/or bulldozers. Road watering activities may include ripping the surface to a depth of two inches, blading the road smooth, and then applying dust suppressants which would reduce the required number of passes with a water truck.

3.4 Transport of Construction Materials

Materials necessary for the construction of the Project facilities (administrative, maintenance, storage, utility, process, etc.), would need to be transported to the Project area via the access routes identified above. For the most part, these materials would be delivered by semi-tractor trailer and/or large delivery trucks and would include, but not be limited to:

- Mobile construction equipment (e.g. bulldozers, scissor lifts, cranes, compactors, etc.);
- Concrete productions systems and supplies (incl. aggregate, cement, binders, and water);
- Structural metal (e.g., I-beam, rebar, joists, frames, grating, etc.);
- Building insulation and waterproofing materials;
- Electrical systems and equipment;
- Surface finishing materials (e.g., plaster, sheet rock, tile, paint, carpet, etc.);
- Roofing materials;
- Fire suppression systems and equipment;
- Interior furnishings;
- Heating, ventilation, and air conditioning systems;
- Plumbing fixtures and equipment;
- Security systems and equipment; and
- Telecommunications equipment.

3.5 Transport of Equipment

The following mining equipment would be utilized for the duration of the Project and would need to be delivered to the site. For the most part, these would be one-off deliveries during the initial years of construction and operation, followed by equipment replacement every three to seven years, depending on use.

- Development jumbos;
- Bolters;
- Powder trucks;

- Utility cassette carriers;
- Loaders;
- Easers;
- Haul trucks;
- Shotcrete transmixers and sprayers;
- Graders;
- Water trucks;
- Load-haul-dump vehicles;
- Scissor lifts;
- Boom trucks;
- Crane;
- Vibratory packer;
- Ambulance;
- Fire truck;
- Buses; and
- A light vehicle fleet.

With the exception of the service equipment, buses, and the light vehicle fleet, which would be driven to the Project, pieces of equipment would be transported on highway-certified, flatbed semi-tractor trailers. Some equipment, such as the mining haul trucks and water trucks, may represent an oversize or overweight load which exceeds the standard or ordinary legal size and/or weight limits for a specified portion of the road or highway. In these cases, delivery may require a special permit (with a fee) specifying a route the load must follow, as well as the dates and times during which the load may travel. Special signals and/or pilot cars may also be required.

3.6 Chemical Reagents

Bulk processing reagents (exclusive of small-quantity laboratory reagents) would be delivered to the site in totes or by tanker trucks. Table 3-1 lists the amounts of bulk processing reagents anticipated to be used at the Project, as well as the number of delivery trucks anticipated to deliver bulk processing reagents to the Project per year. Once delivered to the Project, bulk processing reagents would be stored in bulk tanks while smaller quantities of reagents would be stored in the process plant, warehouse, and/or laboratory.

3.7 Transport of Fuel

The underground mining fleet and most support vehicles would use diesel fuel. A diesel-powered generator system would provide emergency standby power in the event of a utility line power failure. Total diesel fuel requirements for all mining activities, including standby power generation, is the largest consumable at the Project. Diesel for the Project would be transported to the Project by tanker trucks and stored within the

fuel storage area at the plant site or within the tailings management site fuel and lube station at the tailings management site.

Gasoline use would be limited to pick-up trucks and various small equipment engines, and propane would be used for heating buildings and the underground mine. Gasoline and propane would be delivered to the site by tanker trucks.

Table 3-2 includes fuel product usage at the Project and the number of delivery trucks anticipated to deliver petroleum products to the Project per month.

3.8 Transport of Explosives

Explosives would be delivered to the Project in totes or by tanker trucks. Primary explosives products would include the following:

- Sensitized bulk emulsion;
- Electronic detonators;
- Primers, boosters, detonation cord; and
- Stemming.

Anticipated quantities of emulsion to be used during Project operations, and the number of delivery trucks anticipated to deliver emulsion to the Project per month, are provided in Table 3-3.

3.9 Transport of Work Force

The main work force would be transported to the Project via bus (Class 6) from embarkation points in both Ely and Babbitt, thus reducing traffic volumes on access routes. Current plans assume three buses would transport employees from the Babbitt embarkation point (12 total vehicles per day, or six round-trips) and one bus would transport employees to and from the Ely embarkation point (four total vehicles per day, or two round-trips). The Class 6 buses would run seven days per week, 52 weeks per year. Vehicle classifications are shown on Table 3-4.

3.10 Transportation Vehicles

In the United States, commercial truck classification is determined based on the vehicle's gross vehicle weight rating (GVWR). The classes range from 1–8. Trucks are also classified more broadly by the Department of Transportation's Federal Highway Administration (FHWA) which groups classes 1–3 as light duty, 4–6 as medium duty, and 7–8 as heavy duty. It is anticipated that all classes of vehicles would be used to transport materials and personnel to the Project. Vehicle classifications are shown on Table 3-4.

4.0 PRODUCT SHIPMENTS

Concentrate product would be loaded into sealed containers within a negative pressure building prior to being transported off-site. Concentrates would be transferred off-site daily via semi tractor-trailer (Class 7 or 8), bound for a port in the Duluth area for storage and transloading to either rail or vessel for transport to the appropriate market. There would be approximately 16,000 concentrate transport trucks per year. These trucks would run seven days per week during daylight hours. This would result in 40 trucks per day during normal operating conditions, and up to 80 trucks per day during springtime road conditions (additional trips occur when spring weight restrictions are placed on area roadways because trucks would be required to haul lighter loads, thereby resulting in more trucks per day).

5.0 DELIVERY/CONTRACTOR TRUCK TRIPS

The Project would generate approximately 5,400 delivery / contractor trucks per year. Approximately 5,000 of these trucks are assumed to visit the Project throughout the year, which equates to an average of 14 trucks per day. Approximately 400 trucks are expected to visit the Project during winter months to deliver propane. Winter months are assumed to have 150 total days, equating to an additional three trucks per day, seven days a week.

6.0 HAZARDOUS MATERIALS AND SOLID WASTE

6.1 Hazardous Materials

6.1.1 Transportation of Hazardous Materials

Hazardous materials would be transported in accordance with all applicable laws and regulations, including, but not limited to, the following requirements:

- Containers would be prepared for shipment according to the requirements of 49 Code of Federal Regulations (CFR) section (§) 172 for the preparation of shipping papers, marking, labeling, and placarding;
- Materials would be packaged according to 49 CFR § 173, § 178 and § 179;
- Emergency response information would be provided and maintained according to 49 CFR § 172 (Subpart G);
- Personnel involved in the transportation of hazardous materials would be trained according to 49 CFR § 172 (Subpart H); and
- Where applicable, safety and security plans would be developed and implemented in accordance with 49 CFR § 172 (Subpart I).

The Federal Hazardous Materials Regulations found in 49 CFR §171-180 (noted above), govern the transportation of hazardous materials in interstate and intrastate commerce. Minnesota has adopted the Federal Motor Carrier Safety Regulations governing hazardous materials transportation under Minnesota Statutes § 221.033.

6.1.2 Blasting Agents

Blasting agents would be prepared on site by the explosives supplier. With the exception of primers, detonation cord, and stemming, components used to produce the blasting agents (emulsion and boosters) are inert and are classified as hazardous, but not dangerous goods for the purposes of their transport. Bulk emulsion would be transported in cassettes specifically designed and designated for use only for this commodity. These containers would be handled, stored, and labeled in accordance with 49 CFR § 1910.109 in addition to applicable state and local regulations. Bulk emulsion cassettes would not, however, be segregated during transport, but would be shipped along with the rest of the general materials destined for the site. Primers and detonators would be shipped separately under the control of the explosives supplier. Transport companies which handle these materials would require appropriate certifications and licenses.

6.1.3 Acids

Acids would be shipped to the Project area in totes or highway-certified tanker trucks by an experienced and appropriately licensed carrier. The containers would be prominently marked with warning labels and hazard markings as per the applicable regulations. Acid handling and storage practices and processes would comply with 49 CFR § 171 to 179 in addition to applicable state and local regulations.

7.0 SOLID WASTE

All non-hazardous solid waste, including, but not limited to, construction debris, office waste, domestic garbage, and sanitary waste, would be transported off-site for disposal by a licensed third-party contractor. Signs would be installed reminding employees of appropriate disposal practices.

8.0 PROJECT CLOSURE

Following cessation of mining and beneficiation operations, select mining equipment would be shipped off-site for sale or salvage. However, some of the heavy equipment, including loaders and trucks, would remain temporarily onsite and would be used for reclamation purposes. Once completed, these larger pieces of equipment would be disassembled, as needed, and shipped off-site using heavy semi-tractors with flatbed and/or flatbed, low-boy trailers (Class 7 or 8).

Salvageable equipment and construction material from the buildings and process plant facilities would also be shipped off-site using semi-tractor trailer rigs. Non-salvageable demolition debris would likely be transported off-site using highway-certified dump trucks to deliver those materials to the closest municipal landfill or other disposal destination.

The number of trips to remove materials from the site should be roughly equivalent to the number of trips needed to deliver the same materials during the construction period. However, given the extended need for some of the facilities, and thus a staggered closure schedule for the site, traffic associated with closure would be spread out over a longer period than that experienced during the construction phase of the Project.

9.0 POTENTIAL TRANSPORTATION-RELATED IMPACTS

Traffic forecasts were developed for each of the identified key regional corridors as well as the local and USFS roads. The forecasts were determined based on historical AADT trends provided by the Minnesota Department of Transportation (MnDOT) through their Traffic Mapping Application. Based on the estimated generated traffic, a summary of the total number of new daily trips added to the roadway network traveling to and from the Project and the Babbitt and Ely parking lots, as shown in Table 9-1.

The traffic analysis found that, under multiple scenarios, the addition of the proposed mining traffic does not have adverse impacts on the existing roadway network. The roadways along the routes currently operate at an “A” level of service (LOS) both under existing and future (2040) anticipated conditions. LOS “A” is described as having traffic flows at, or above, the posted speed limit and motorists having complete mobility between lanes. LOS “A” generally occurs late at night in urban areas and frequently in rural areas.

10.0 OPERATING PRACTICES

TMM is developing a transportation policy, comprised of a series of operating practices, which would govern general transportation and the transport of chemicals and petroleum products to the Project. These operating practices would also govern personnel transport to and from the site. These operating practices are designed to prevent unnecessary and undue degradation during construction, operation, and reclamation of the Project and are derived from the general requirements established by the BLM, current industry best practices, as well as water, air quality, and other environmental protection regulations.

The operating practices would be considered TMM policy. They would be adhered to by the company, and contractual commitments for compliance would be required of all chemical and petroleum suppliers. These operating practices also describe major

preventive response procedures and future inspections and training programs, to be implemented by TMM.

Operating practices include, but are not limited to, those listed below.

10.1 Operating Practice #1

TMM would utilize current best management practices and dust abatement techniques on unpaved roads to minimize the generation of fugitive dust. This may not only include the application of water and / or dust suppression reagents, but also include reducing vehicle speeds below 30 miles per hour to reduce fugitive dust.

10.2 Operating Practice #2

Contract and full-time workers would be required to adhere to all Minnesota traffic laws and driving rules as specified under Minnesota Statutes, including, but not limited to: driving while impaired (169A); accidents (169.09); reckless or careless driving (169.13); and speed limits, zones, and radar (169.14), etc. Additional attention would be focused on safe driving habits, such as the use of seat belts, restrictions on texting, accessing the internet, hand-held cell phone use during vehicle operation, and driving while fatigued or tired.

10.3 Operating Practice #3

Management, administrative, technical staff, and a limited number of employees that do not work 12-hour shifts, would be responsible for their own transportation to the Project. Contractors would also be responsible for their own transportation to the Project but would be encouraged to take the employee bus from either the Ely or Babbit embarkation points.

Employees using company vehicles would also make occasional trips to and from Babbitt, Ely, Duluth, and Minneapolis-St. Paul.

10.4 Operating Practice #4

Maximum speed over the unpaved portions of transportation routes would be 30 miles per hour. When road conditions are poor, drivers would be required to travel at reduced speeds (below 25 miles per hour) to ensure safe passage to and from the site.

10.5 Operating Practice #5

Orders of supplies and consumables would be made at the TMM purchasing office in Babbitt. No solicitors would be permitted at the Project site. This practice would reduce the volume of vehicles to and from the Project during normal business hours.

10.6 Operating Practice #6

Shipping of petroleum products (gasoline and diesel fuels) and other hazardous chemicals to the site would be by a licensed transport company on a regular schedule using a predetermined route and pilot guide vehicles (as per applicable MnDOT regulations), as necessary.

10.7 Operating Practice #7

Onsite equipment and supplies, including bagged absorbent, booms, weirs, and tools would be readily available for timely deployment by trained TMM personnel and applicable regulations posted conspicuously regarding reporting spills and emergency procedures.

10.8 Operating Practice #8

Employees involved in the transport or use of petroleum products at the Project, or involved in maintenance of petroleum storage and dispensing systems, would receive training and instruction in the areas of:

- Operation and maintenance of equipment necessary to prevent unintended discharges;
- Location and use of spill containment and cleanup supplies;
- Applicable pollution control laws, rules, and regulations;
- The Project Spill Contingency Plan and the forthcoming Spill Prevention, Control, and Countermeasures Plan;
- Discharge prevention; and
- Changes pertaining to the above item.

11.0 REFERENCES

Bureau of Land Management (BLM), 2012. Travel and Transportation Management Handbook. BLM Handbook H-8342-1.

Peterbilt, 2019. Accessed online at https://peterbilt.cummins.com/on-highway-truck-weight-rating-class. June 20, 2019.

TABLES

371 Table 3-1: Bulk Processing Reagents

Reagent	Annual Consumption (short tons [st] per year)	Transport Loads (st per delivery)	Deliveries per year (approximate)	Storage Capacity (st / type)
Triethylenetetramine	650	19.6	34	25 / Bulk Solution
Sodium Sulphite	610	15.4	40	25 / Bags
Aerophine 3418A	60	20.0	3	20 / Bulk Solution
Sodium Isopropyl Xanthate	1,400	15.4	91	25 / Bags
Methyl Isobutyl Carbinol	800	16.2	50	30 / Bulk Solution
Lime	10,500	15.4	680	140 / Bulk
Copper Sulphate	600	15.4	39	25 / Bags
Sulfuric Acid	840	20.0	42	32 / Bulk Solution
Flocculant (Concentrate)	3	15.4	8	5 / Bags
Flocculant (Tails)	120	15.4	8	5 / Bags
Binder (Slag-Cement Mix)	34,000	15.4	2,210	450 / Bulk

372

373 Table 3-2: Primary Fuels and Lubricants

374

Fuel or Lubricant	Annual Consumption (L [liter] per year)	Storage (m^3)	Amount per Delivery (L / st)	Anticipated Trucks per Month	Approximate Consumption per Day (L per day)	Storage Time (days)
Diesel (For Underground)	15,000,000	200	30,000 L / 25 st	44.7	41,096	5
Diesel (For Surface)	300,000	Included with above	Included with above	Included with above	822	Included with Above
Gasoline	300,000	20	20,000 L / 14.4 st	1.3	822	24
Diesel (For Dry Stack Facility)	678,000	20	7,000 L / 6 st	8.5	1,858	11
Propane	12,720,000	160	10 st	53.1	34,849	5

375

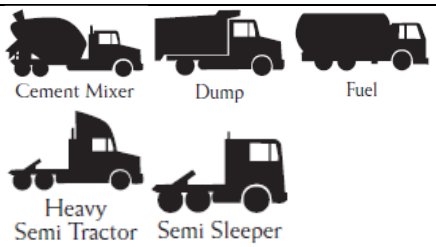
376 Table 3-3: Anticipated Emulsion Quantities

Reagent	Annual Consumption	Delivered Form	Storage	Amount/ Delivery	Anticipated Trucks/ Month	Approximate Consumption per day
Emulsion (Titan® 7000)	5,475 st	Tanker	20 st insulated silo	15 st	30	15 st

377

378

Table 3-4: Vehicle Classifications

FHWA Group	Class	GVWR (pounds)	Typical Mine Site Examples
Light Duty	1	0–6,000	
Light Duty	2	6,001–10,000	
Light Duty	3	10,001–14,000	
Medium Duty	4	14,001–16,000	
Medium Duty	5	16,001–19,500	
Medium Duty	6	19,501–26,000	
Heavy Duty	7	26,001–33,000	
Heavy Duty	8	Over 33,000	

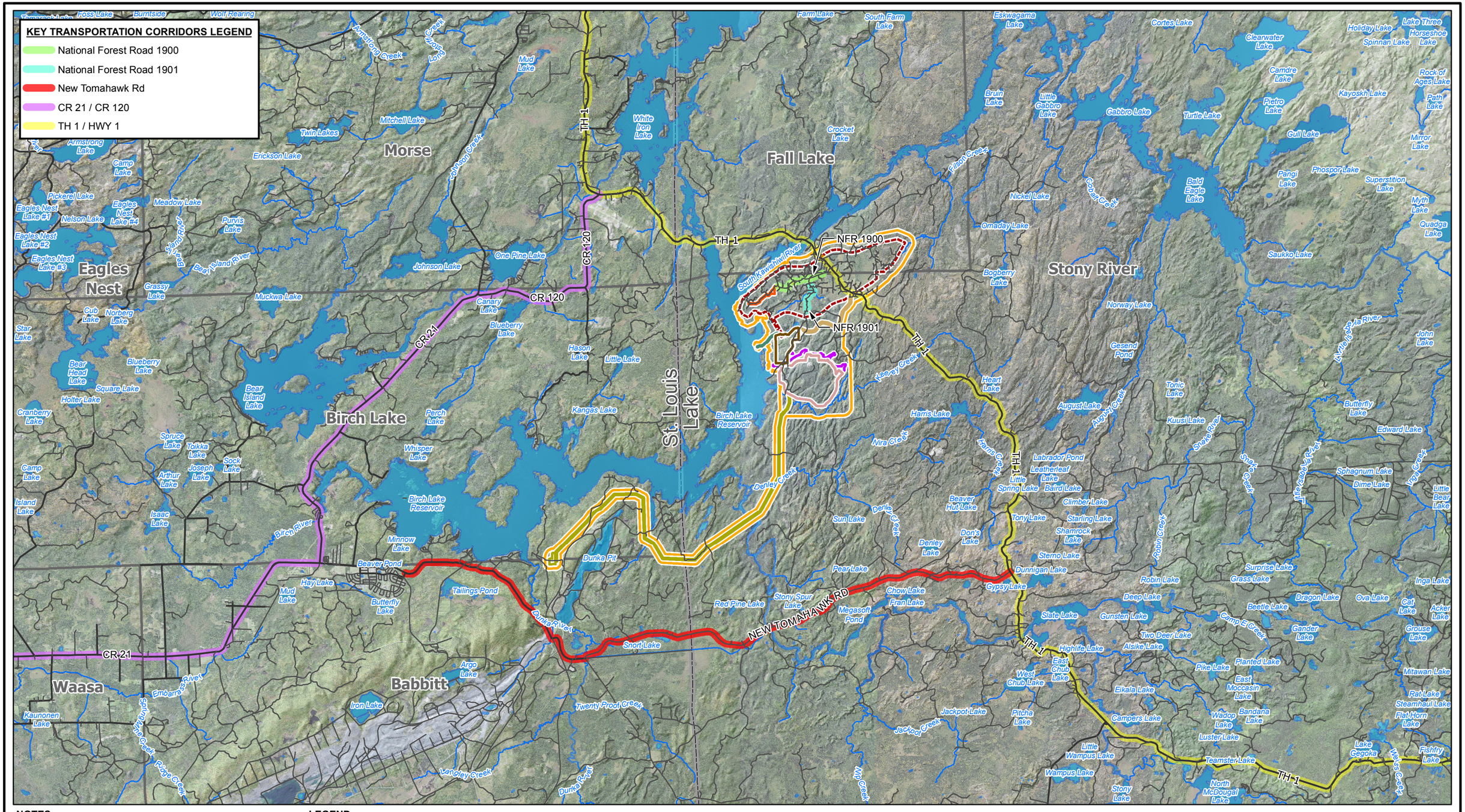
(Peterbilt, 2019)

382 Table 9-1: Traffic Forecasts

Trip Type	Number of Trips (per day)
Trip Type by Vehicle	
Truck Trips	194
Bus Trips	16
Employee Vehicle Trips	664
Trip Destination	
Total Trips Travelling to and from the Project	874
Personal Trips to and from Babbitt Parking Lot	490
Personal Trips to and from Ely Parking Lot	144

383

FIGURES



NOTES:

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area

TWIN METALS MINNESOTA

FIGURE 3-1

KEY TRANSPORTATION CORRIDORS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019

APPENDIX F

SPILL CONTINGENCY PLAN

SPILL CONTINGENCY PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
Prepared by SRK Consulting (U.S.), Inc.

Document No. TMM-ES-115-0005
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	N/A	1.0

REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SUMMARY AND OBJECTIVES 1
2.1 SPILL CONTINGENCY PLAN REVIEW 2
3.0 FACILITY AND OPERATIONS OVERVIEW 2
3.1 FACILITIES 2
3.2 CHEMICAL USAGE 2
3.3 ORGANIZATION AND PERSONNEL 3
4.0 SPILL PREVENTION 3
4.1 INSPECTIONS 3
4.2 TRANSFER OF PETROLEUM PRODUCTS 3
4.3 PREVENTIVE MAINTENANCE 3
4.4 SPILL CONTAINMENT STRUCTURES 3
5.0 EMERGENCY PREPAREDNESS 4
5.1 PERSONAL PROTECTIVE EQUIPMENT 4
5.2 HAZARDOUS MATERIALS IDENTIFICATION 4
5.3 HAZARDOUS MATERIAL SPILL PREVENTION AND COUNTERMEASURES 4
6.0 SPILL RESPONSE ACTIVITIES 5
6.1 EMERGENCY RESPONSE PROCEDURES 5
6.2 DUTIES OF MINE PERSONNEL 6
6.3 EMERGENCY RESPONSE FOR CHEMICAL SPILLS 7
6.3.1 Lime – Calcium Oxide 7
6.3.2 Sulfuric Acid 8
6.3.3 Triethylenetetramine 8
6.3.4 Sodium Sulfite 9
6.3.5 Aerophine 3418A 10
6.3.6 Sodium Isopropyl Xanthate 10
6.3.7 Methyl Isobutyl Carbinol 11
6.3.8 Copper Sulfate 12

6.3.9 Hydraulic Fluid 12
6.3.10 Emulsion (Titan® 7000) 13
6.3.11 Gasoline and Diesel Fuel 14
6.3.12 Propane 14
6.3.13 Automatic Transmission Fluid 15
6.3.14 Bulk Oils 16
6.3.15 Ethylene Glycol (Antifreeze) 16
7.0 EMERGENCY SERVICES AND CONTACT INFORMATION 17
8.0 REPORTING AND NOTIFICATION 18
8.1 INCIDENT REPORTING FORMS 18
9.0 TRAINING 18

TABLES

Located in Tables section at end of document:

Table 7-1 Emergency Contact Information

FIGURES

Located in Figures section at end of document:

Figure 3-1 General Project Layout

ATTACHMENTS

Located in Attachments section at end of document

Attachment F.1 Distribution Table

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

§	section
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
etc.	abbreviation for the Latin phrase et cetera meaning "and other similar things" or "and so forth"
i.e.	abbreviation for the Latin phrase *id est* meaning “that is (to say)”
km	kilometer
MSHA	Mine Safety and Health Administration
Project	Twin Metals Minnesota Project
SCP	Spill Contingency Plan
SDS	Safety Data Sheets
SOP	standard operating procedures
TMM	Twin Metals Minnesota LLC

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 kilometers) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at: http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process. TMM retained SRK Consulting (U.S.), Inc. to complete this Spill Contingency Plan (SCP).

2.0 SUMMARY AND OBJECTIVES

This SCP establishes responsibilities and guidelines for actions to be taken by mine personnel in the event of a spill. Additionally, this SCP would inform the development of a Spill Prevention, Control, and Countermeasures plan, as per Minnesota Statutes section (§) 115E. These guidelines are intended to assist personnel and responsible parties in making timely decisions and taking positive actions toward a successful resolution of the problem.

This SCP identifies potential sources of spills, establishes measures of prevention, and defines control, cleanup, and reporting procedures in the event of a reportable spill. A “reportable spill” is a spill that is greater than or equal to the reportable quantity for a material. The reportable quantity for petroleum products is five gallons as per Minnesota Statutes § 115.061. Reportable quantities for other hazardous materials are defined in 49 Code of Federal Regulations (CFR) § 172.101.

More specifically, the objectives of the SCP are to:

- Reduce the potential for accidental spills and environmental degradation by taking precautionary measures and being prepared for potential emergencies;
- Provide the operating facility with the necessary information to properly respond to a hazardous material emergency situation;
- Define personnel roles for emergencies involving hazardous conditions; and
- Include a self-audit program to ensure that the plan and related response activities meet environmental protection objectives.

This SCP has been prepared as an attachment to the Mine Plan of Operations but is also maintained as a stand-alone document assigned to personnel and to individuals on the distribution list provided in Attachment F.1.

2.1 Spill Contingency Plan Review

This SCP is preliminary. As the Project proceeds and final information concerning permit requirements, construction, and operations is developed, this SCP would be revised. This SCP would also be reviewed and updated on a regular basis during Project operations to ensure it remains applicable. Modifications or changes would be made if and when conditions pertaining to this SCP change at the Project. Modifications would be issued to SCP-holders as recorded in the distribution table (Attachment F.1).

3.0 FACILITY AND OPERATIONS OVERVIEW

TMM plans to operate an underground mine and beneficiation plant to extract copper, nickel, and platinum group metals over the Project's active mine life. As part of mining and processing operations, a number of reagents and hazardous materials would be transported and stored for use at the Project area. In addition, chemicals would also be used on a day-to-day basis during normal mining and processing activities.

3.1 Facilities

The proposed Project developments would occur within the Project area, shown on Figure 3-1 and would consist of the following:

- Underground mine area, including portals and declines, mine ventilation system infrastructure, and underground facilities;
- Plant site, including the ore stockpiles, process plant, and plant site surface infrastructure;
- Tailings management site, including a dry stack facility;
- Transmission corridor;
- Water intake pipeline; and
- Access road.

3.2 Chemical Usage

TMM would transport, store, and use a variety of fuels and reagents for the Project. A summary of these materials is included in Section 6.3. These fuels and reagents would be transported, used, and stored in accordance with applicable federal, state, and local regulations and guidelines overseen and / or enforced by U.S. Department of Transportation, Minnesota Department of Transportation, Bureau of Alcohol,

Tobacco, Firearms, and Explosives, Department of Homeland Security, and the Mine Safety and Health Administration (MSHA).

3.3 Organization and Personnel

The Project is operated by TMM. The primary contact for the Project would be the General Manager. Contact information is included in Section 7.0.

4.0 SPILL PREVENTION

4.1 Inspections

Tanks, pipelines, and process components would be inspected for leaks and/or damage on a daily basis. Employees, contractors, and other workers on-site would be directed to immediately report observed leaks and facility/equipment damage to the working supervisor and TMM's Environmental Department for assessment. The working supervisor would be responsible for scheduling and implementing necessary repairs as soon as possible. If leaks or damages are found, the working supervisor would be required to inform the Environmental Department, in writing, of the intended schedule and manner of repair.

4.2 Transfer of Petroleum Products

Employees, contractors, and other workers responsible for the transfer of petroleum products would remain at the fill point until fill procedures are completed and the transfer line is placed back in the proper storage location. Spillage would be reported to the maintenance supervisor and the Environmental Department, and cleanup would be planned and scheduled. Agencies would be verbally notified of the spill if the amount is greater than or equal to five gallons, which is the reportable quantity for petroleum products as per Minnesota Statutes § 115.061. TMM policy would be to start remediation of spills within 24 hours.

4.3 Preventive Maintenance

Preventive maintenance would be performed to maintain the integrity of systems. Faulty valves, joints, elbows, etc. that could cause the release of possible contaminants outside a containment structure would be repaired or replaced immediately upon identification.

4.4 Spill Containment Structures

Containment structures would be provided for petroleum, liquid reagents, and processing fluid storage tanks. As per 40 CFR § 267.197, containment structures would have the capacity to contain at least 110 percent of the largest tank or series of tanks (i.e., multiple tanks connected by pipes) within the structure, plus the 25-

year, 24-hour storm event if the structure is located outdoors. Pipes containing petroleum products, liquid reagents, or processing fluids would be double-walled and/or would have a system of leak detection and secondary containment, as determined to be necessary.

5.0 EMERGENCY PREPAREDNESS

5.1 Personal Protective Equipment

Mine and process personnel would be required to wear personal protective equipment including hardhats, steel-toed and steel-shanked boots, leather gloves, eye protection, safety vests, and hearing protection (where necessary), as required by MSHA. Process personnel would also be provided with chemical-resistant gloves, coats, pants, face shields, and dust masks or air-purifying respirators, depending on the particular task being performed at a given time.

5.2 Hazardous Materials Identification

A variety of chemicals and reagents would be used for mining and ore processing activities. Hazardous materials are defined by 49 CFR § 172 according to the following characteristics:

- Toxicity;
- Explosive properties;
- Corrosiveness;
- Flammability;
- Oxidizing properties; and
- Potential for violent or other chemical reaction when mixed.

Safety Data Sheets (SDS) would be maintained in strategic locations at the mine for hazardous materials. The SDS provides relevant information on physical characteristics including: hazardous reactivity; fire and explosion data; and health hazard information including safety precautions and first aid/medical treatment. Tanks and other containers would be clearly labeled as to their contents.

5.3 Hazardous Material Spill Prevention and Countermeasures

Chemicals would be stored at the most efficient location according to their place of use. Small quantities of chemicals would be stored in secure, fire-proof cabinets adjacent to their area of use. In areas where corrosive materials are stored or used, the concrete would be covered with an impermeable compound, resistant to corrosive chemicals. Only chemical groups compatible with one another would be stored together. Incompatible materials would not be stored in proximity to one another (i.e., same room or cabinet).

Reagent tanks would be located within secondary containment. The secondary containment would hold 110 percent of the largest volume tank or tanks in series and if out of doors, additional capacity to hold the 100-year, 24-hour storm event. The floor of the reagent areas would be sealed to prevent spills from entering cracks or permeating the concrete and being released to the environment.

Smaller quantities of hydrocarbons and regulated materials would be located at the mine services building and the concentrator services building. These materials would be kept in their original containers or in containers clearly labeled to indicate their contents. The containers would be stored in storage cabinets or placed within secondary containment.

Spill containment and cleanup equipment would be maintained at strategic locations throughout the mine including:

- Oil absorbent rolls;
- Oil absorbent pads;
- Oil absorbent booms;
- Oil absorbent pillows;
- Spill kits;
- Front-end loader;
- Backhoe or excavator;
- Graders; and
- Dozers.

If the spill is of significant size and/or duration, special cleanup efforts, such as those provided by environmental contractors, may be deemed necessary.

6.0 SPILL RESPONSE ACTIVITIES

6.1 Emergency Response Procedures

The following are the standard operating procedures (SOPs) that would be used in the event of a hazardous material release:

1. First responder reports incident and notifies their supervisor;
2. Supervisor notifies the General Manager and Environmental Manager;
3. Environmental Manager will be responsible for contacting off-site emergency response teams at the General Manager's direction (discussed further in Section 7.0);
4. Gather information about the incident;
5. Complete preliminary information on incident report form;
6. Contact and transmit information to emergency response team;
7. Emergency response team dispatched to incident;
8. Contact additional emergency units if necessary;

9. Contain spill material and control release;
10. Contact off-site specialists/contractors as required by the circumstances;
11. Remove and secure contaminated material;
12. Arrange for proper disposal of contaminated material;
13. Supervisor completes incident report form;
14. After stabilization of the release, verbally notify agencies of the spill if amount is greater than or equal to the reportable quantity as per Minnesota Statutes § 115.061 for petroleum products or as per 40 CFR § 172.101 for other hazardous materials (notification procedures are discussed further in Section 8.0);
15. Follow incident up with a debriefing; and
16. Evaluate emergency response procedures and modify as necessary.

6.2 Duties of Mine Personnel

General Manager

The General Manager would be notified as soon as possible when a reportable spill or release occurs. The General Manager would direct public statements to the media, if required.

Emergency Response Team

The Emergency Response Team would include employees who have been specially trained to work with hazardous materials in a safe and orderly manner. The team would be trained in the use of safety gear and would promote and demonstrate safe remediation practices. The prime responsibility of the team would be to assess a scene for hazards, act professionally, and conduct cleanup procedures as outlined in the previous section.

Environmental Manager

The Environmental Manager would determine or verify pertinent facts about the incident, including the amount and location of the spill or release, probable direction and time of travel of the spill, resources required at the scene, and the property that may be affected. The Environmental Manager may advise, instruct, and / or direct containment, countermeasures, and cleanup of the release. The Environmental Manager would assess the area to determine the effect and extent of the spill or release and report the information to the General Manager.

Safety Officer

The Safety Officer would ensure the safety of persons involved with a spill or release. Once on the scene, the Safety Officer would evaluate the area for dangers and would ensure that persons involved are equipped with the appropriate safety gear and have received the proper training. The Safety Officer would also determine if tests for toxic gases are required prior to handling of the spilled material.

Supervisor

The foreman of an area where a spill or release occurs would be responsible for coordinating the initial containment. The supervisor would be responsible for determining if the spill requires the Emergency Response Team. Once the spill or release is controlled, the supervisor would verify if the spill is or is not a reportable spill (i.e. a spill is reportable if the volume of the spill is greater than or equal to the reportable quantity identified for the material as per 40 CFR § 302) and notify the Environmental and Safety departments. Reporting of reportable spills would be further handled as discussed in Section 8.0.

6.3 Emergency Response for Chemical Spills

TMM would receive, store, use, and transport a variety of chemicals at the Project. These chemicals would be handled according to standard industry practices which would include the use of personal protection equipment, task training, and preventive maintenance. In spite of training and precautions, unplanned events may occur that require rapid response to protect worker health, prevent or reduce releases to the environment, and reduce damage to equipment.

6.3.1 Lime – Calcium Oxide

Specifications

Lime would be shipped by trailer truck and consists of white, odorless solid pebbles or powder that would be pneumatically transferred from the truck to a lime silo.

Personal Safety

1. Wear an approved dust respirator, work gloves, goggles, and a full covering of clothing.
2. Do not use water.

Immediate Response

1. Follow SOPs as outlined in Section 6.1.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Scoop or sweep up spilled lime and place in a suitable container.
3. Excavate the contaminated soil and place within a secured area.
4. The reclaimed lime may be placed into the process circuit with approval from the Process Supervisor.

6.3.2 Sulfuric Acid

Specifications

Sulfuric acid would be shipped to the site in totes or a tanker truck. Sulfuric acid is a colorless, odorless, syrupy liquid.

Personal Safety

1. Wear a self-contained breathing apparatus or an approved respirator, goggles, rubber suit, rubber gloves, and boots.
2. Avoid contact with organics, metals, chlorates, alkalines, carbides, fulminates, reducing agents, nitrates, acetic acid, and oxidizing agents.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outlined in Section 6.1 above.
3. Evacuate and isolate the immediate 50-foot (15.2-meter) area to avoid personnel exposure.
4. For a pipeline leak, adjust appropriate valves to isolate the system and stop the leak.
5. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Neutralize pooled solution with soda ash or lime. Verify that the solution is neutralized with a pH tester.
2. If possible, place neutralized solution back in the process circuit.
3. Excavate the contaminated soil and mix with lime. Contact the Environmental or Safety department for disposal options.
4. Neutralized material may be placed in previously approved areas.

6.3.3 Triethylenetetramine

Specifications

Triethylenetetramine would be shipped to the site in totes or a tanker truck. It is a colorless oily liquid which may be yellowish due to impurities from air-oxidation and that has a fishy or ammoniacal odor.

Personal Safety

1. Wear an approved respirator for vapors and dust, goggles, faceshield, overalls/polyvinyl chloride apron, rubber gloves, and rubber boots. A self-contained breathing apparatus should be worn in the case of large spills.

2. Eliminate ignition sources and use water spray to reduce vapors.
3. Avoid contact with organic absorbents during spills.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outlined in Section 6.1 above.
3. Evacuate and isolate the immediate 50-foot (15.2-meter) area to avoid personnel exposure.
4. Dike the area to contain the spill. Prevent entry into confined areas.
5. In the case of a small spill, dilute with water and mop up or absorb with inert dry material and place in an appropriate waste disposal container.
6. In the case of a large spill stop leak if risk free, absorb with dry earth/sand/other non-combustible, do not get water inside container, do not touched spilled material, use water spray curtain to divert vapor drift, prevent entry into sewers/basements/confined spaces, and eliminate ignition sources.

Containment, Countermeasures, and Cleanup

1. Use appropriate tools to put the spilled solid in a waste disposal container.
2. Follow SOPs as outlined in Section 6.1 above.
3. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.4 Sodium Sulfite

Specifications

Sodium sulfite would be shipped to the site in bulk bags or barrels. It is a white crystal or odorless to sulfurous white powder.

Personal Safety

1. Wear an approved dust respirator, safety glasses, gloves, and lab coat. A self-contained breathing apparatus should be worn in the case of large spills, as well as splash goggles, full suit, boots, and gloves.
2. Provide ventilation to the area.
3. Avoid heating, contact with acids, and contact with oxidants.

Immediate Response

1. In the case of a small spill dilute with water and mop up or absorb with inert dry material.
2. In the case of a large spill absorb with dry earth, sand, or other non-combustible material.

3. Stop leak if safe and dike if needed.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Neutralize residue with a dilute solution of acetic acid.
4. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.5 Aerophine 3418A

Specifications

Aerophine 3418A would be shipped to the site in containers or tanks. The liquid is clear to yellowish and odorless.

Personal Safety

1. Wear an approved respirator, face shield, apron, work pants, long sleeve shirt, gloves, and boots. A self-contained breathing apparatus should be worn in the case of large spills.
2. Provide ventilation to the area.
3. Use water spray to divert or reduce vapors.

Immediate Response

1. In the case of spill, cover with inert absorbent material, sweep up, and place in waste disposal container. Flush area with water.
2. Stop leak if safe and dike if needed.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Neutralize residue with a dilute solution of acetic acid.
4. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.6 Sodium Isopropyl Xanthate

Specifications

Sodium isopropyl xanthate would be shipped to the site as powder or pellets. The powder is yellowish, with a pungent odor.

Personal Safety

1. Wear an approved respirator, face shield, suit, gloves, and boots. A self-contained breathing apparatus should be worn in the case of large spills.
2. Provide ventilation to the area.
3. Keep dry, do not get wet.
4. Avoid contact with acids, oxidizing agents, and moisture.

Immediate Response

1. In the case of a spill, shut off sources of ignition, clear area of unprotected personnel, do not allow in drains/sewers, do not allow to get wet, wear a self-contained breathing apparatus, and vacuum solid spills instead of sweeping.
2. Stop leak if safe and dike if needed.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.7 Methyl Isobutyl Carbinol

Specifications

Methyl isobutyl carbinol would be shipped to the site in containers or tanks. The liquid is clear with an alcohol odor.

Personal Safety

1. Wear an approved respirator, face shield, suit, gloves, and boots. A self-contained breathing apparatus should be worn in the case of large spills.
2. Provide ventilation to the area.
3. Use water spray to divert or reduce vapors.
4. Avoid contact with acids and oxidizers.
5. Eliminate ignition sources.

Immediate Response

1. In the case of a spill, contain released product, pump into suitable containers, use absorbent material to clean up.
2. Stop leak if safe and dike if needed.
3. Dilute vapors with water curtain.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.8 Copper Sulfate

Specifications

Copper sulfate would be shipped to the site in bulk. Copper sulfate is a grey odorless powder or liquid solution.

Personal Safety

1. Wear protective gloves, clothing, safety glasses, respirator if necessary, and face shield. A self-contained breathing apparatus should be worn in the case of large spills.
2. Provide ventilation to the area.
3. Avoid dust, excess heat, exposure to moisture, strong bases, metals, alkali metals, and powdered metals.

Immediate Response

1. In the case of a spill sweep up or vacuum up spillage and collect in suitable container for disposal, avoid dust formation, do not flush into surface water or sewer system.
2. Stop leak if safe and dike if needed.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.9 Hydraulic Fluid

Specifications

Hydraulic fluid is a blend of ingredients which may vary slightly by manufacturer. It is a clear fluid with a slight odor. Shipments would be delivered to the site in containers or tanks.

Personal Safety

1. No particular safety equipment is required, although gloves are recommended.

Immediate Response

1. Dike area if needed.
2. Remove contaminated soils and use dry materials to soak up spills.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Use appropriate tools to put the spilled solid in a waste disposal container.
3. Excavate the contaminated soil. Contact the Environmental or Safety department for disposal options.

6.3.10 Emulsion (Titan® 7000)

Specifications

Emulsion would be shipped to the site by tanker truck.

Personal Safety

1. Stay upwind, out of fumes, and keep out of low areas.
2. Wear rubber gloves and boots, eye protection, and face protection.
3. No smoking or open flames near gasoline or diesel fuel.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outline in Section 6.1 above.
3. Remove sources of ignition.
4. Evacuate and isolate the immediate area to avoid personnel exposure.
5. Stop the leak without personal safety risks.
6. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Spills should be scraped up for disposal and an inert absorbent material such as sand or vermiculate should be spread over the area. Material should be placed in a clean approved container.
2. Spills should be disposed of according to applicable local and national regulations.

3. Contaminated bulk product recovered from a spill should be passed through a 10 millimeter screen before pumping. The screened material should only then be pumped using a double diaphragm positive displacement pump.

6.3.11 Gasoline and Diesel Fuel

Specifications

Gasoline and diesel fuel would be shipped to the site by tanker truck.

Personal Safety

1. Stay upwind, out of fumes, and keep out of low areas.
2. Wear rubber gloves and boots.
3. No smoking or open flames near gasoline or diesel fuel.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outline in Section 6.1 above.
3. Remove sources of ignition.
4. Evacuate and isolate the immediate area to avoid personnel exposure.
5. Stop the leak without personal safety risks.
6. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Remove diesel-contaminated soil and place in a designated area for removal and disposal.
2. Gasoline-contaminated soil would be temporarily stored on a synthetic liner and would be covered to prevent volatilization. Contact the Environmental Department for appropriate disposal options.
3. Diesel or gasoline liquids recovered from a spill would be placed in drums or dumpsters for proper disposal.

6.3.12 Propane

Specifications

Propane would be shipped to the site by tanker truck.

Personal Safety

1. Stay upwind, out of fumes, and keep out of low areas.
2. Wear rubber gloves and boots.
3. No smoking or open flames near propane.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outline in Section 6.1 above.
3. Remove sources of ignition.
4. Evacuate and isolate the immediate area to avoid personnel exposure.
5. Stop the leak without personal safety risks.
6. For a pipeline leak, adjust appropriate valves to isolate the system and stop the leak.
7. Dike the area to contain the spill.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Remove propane-contaminated soil and place in designated area for removal and disposal.
3. Propane liquid recovered from a spill would be placed in drums or dumpsters for proper disposal.

6.3.13 Automatic Transmission Fluid

Specifications

Automatic transmission fluid would be shipped to the site by tanker truck. It is a red, transparent-colored liquid.

Personal Safety

1. Provide adequate ventilation.
2. Wear rubber gloves, goggles, boots, and an approved respirator when necessary.
3. No smoking or open flames in the area.

Immediate Response

1. Notify the Environmental and Safety departments of the spill and request special instructions for personnel safety during cleanup.
2. Follow the SOPs as outlined in Section 6.1 above.
3. Remove sources of ignition.
4. Isolate the spill area and stop the leak without personal safety risks.
5. For a pipeline leak, adjust appropriate valves to isolate the system and stop the leak.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Contact the Environmental Department for appropriate disposal options.
3. Recover free product for recycling or disposal.
4. Use sand, earth, or absorbent material to absorb from spill area.
5. Remove contaminated soil and place in designated area for removal and disposal.

6.3.14 Bulk Oils

Specifications

Bulk oils would be shipped to the site in 55-gallon (208-liter) drums or in bulk by tanker truck.

Personal Safety

1. Wear rubber gloves and boots.

Immediate Response

1. Follow the SOPs as discussed in Section 6.1 above.
2. Remove sources of ignition.
3. Stop the leak.
4. Dike the area if the spill is large.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Pump pooled oil into 55-gallon (208-liter) drums. Contact the Environmental Department for additional instruction.
3. Remove contaminated soil and place in a designated area for removal and disposal.

6.3.15 Ethylene Glycol (Antifreeze)

Specifications

Shipped in tanker trucks at 50 percent ethylene glycol, the material has a distinctive green color and a pH of 9.

Personal Safety

1. Wear rubber gloves, eye protection, and self-contained breathing apparatus.
2. In the event of fire, avoid contact with strong acids, bases, and oxidizers.
3. Thoroughly wash contacted skin and clothing.

Immediate Response

1. Follow the SOPs as discussed in Section 6.1 above.
2. Safely stop the source of a leak or spill and contain.
3. Properly flag and mark the spill area. Isolate the spill from exposure to wildlife.

Containment, Countermeasures, and Cleanup

1. Follow SOPs as outlined in Section 6.1 above.
2. Reclaim free solution.
3. Excavate contaminated soils and place on a synthetic liner. Contact the Environmental Department for appropriate disposal options. Do not mix hydrocarbon and ethylene glycol contaminated soils.

7.0 EMERGENCY SERVICES AND CONTACT INFORMATION

Depending on the nature of the emergency, mine personnel responding would first contact TMM emergency services via two-way radios installed in vehicles and heavy equipment. If determined to be necessary, the Saint Louis County Sheriff's Office and additional regulatory agencies (as required) would be contacted once the immediate threat has been stabilized. Emergency contact information is provided in Table 7-1.

If necessary, additional response may also be provided by the Ely fire department, located approximately 15 miles (24 km) from the Project, or the Morse Fall Lake fire department located approximately 16 miles (26 km) from the Project.

The closest major medical center to the mine is the Ely Bloomenson Community Hospital in Ely, Minnesota, approximately 15 road miles (24 km) from the Project site. This facility has an emergency room and other facilities adequate to handle emergencies that may occur. If immediate care is necessary, the Life Link III Air Service program out of Hibbing, Minnesota (24-hour), or Cloquet, Minnesota (9:00 am – 9:00 pm) is equipped to provide rapid air transportation of critically injured/ill persons.

Emergency response vehicles and a trained mine rescue team would respond to fire and medical emergencies at the site. Mine rescue and fire response teams may be available to assist with off-site response if requested by agency personnel or others. However, TMM anticipates that local and regional agencies would maintain sole responsibility for response to incidents outside of the Project. A separate radio frequency would be established for emergency use, and emergency response and communication protocols would be established.

A helipad would be located next to the mine services building in the event of an emergency requiring medical evacuation.

8.0 REPORTING AND NOTIFICATION

TMM's environmental director or designee would be responsible for incident reporting. If the release is determined to be a reportable quantity, the incident would be reported to the appropriate agency or agencies by telephone immediately after stabilization of the release. Contact information for potentially relevant agencies are as follows:

- Minnesota Duty Officer, Minnesota Pollution Control Agency at 1.651.649.5451 (in-state) or 1.800.422.0798 (out of state);
- Minnesota Department of Natural Resources notification number at 1.888.646.6367 (in-state) or 1.651.296.6157 (out of state);
- Local Emergency Planning Committee – to be determined;
- National Response Center at 1.800.424.8802; and
- Bureau of Land Management (BLM)-Northeastern States Office at 414.297.4400.

Transportation incidents would be reported to 911.

TMM would also be responsible for obtaining special authority for emergency operations where equipment, personnel, or materials are required for the containment of spills or removal of hazardous material.

8.1 Incident Reporting Forms

The following is a list of incident reporting forms and checklists which would be developed prior to initiation of operations and made available to personnel:

- Site Safety Plan;
- Checklist for Person Identifying Emergency;
- Emergency Response Team Leader Checklist;
- Incident Scene Checklist;
- Operator Checklist;
- Safety Specialist Checklist;
- Site Access Control Checklist; and
- Hazardous Materials Checklist.

These forms would be used to document incidents that occur as well as assist mine personnel during an emergency.

9.0 TRAINING

Employees would be trained in the details of this SCP and that of the Health and Safety Management Plan prepared for TMM at least annually. Training records would be retained in employee personnel files and in the facility operating record.

TABLES

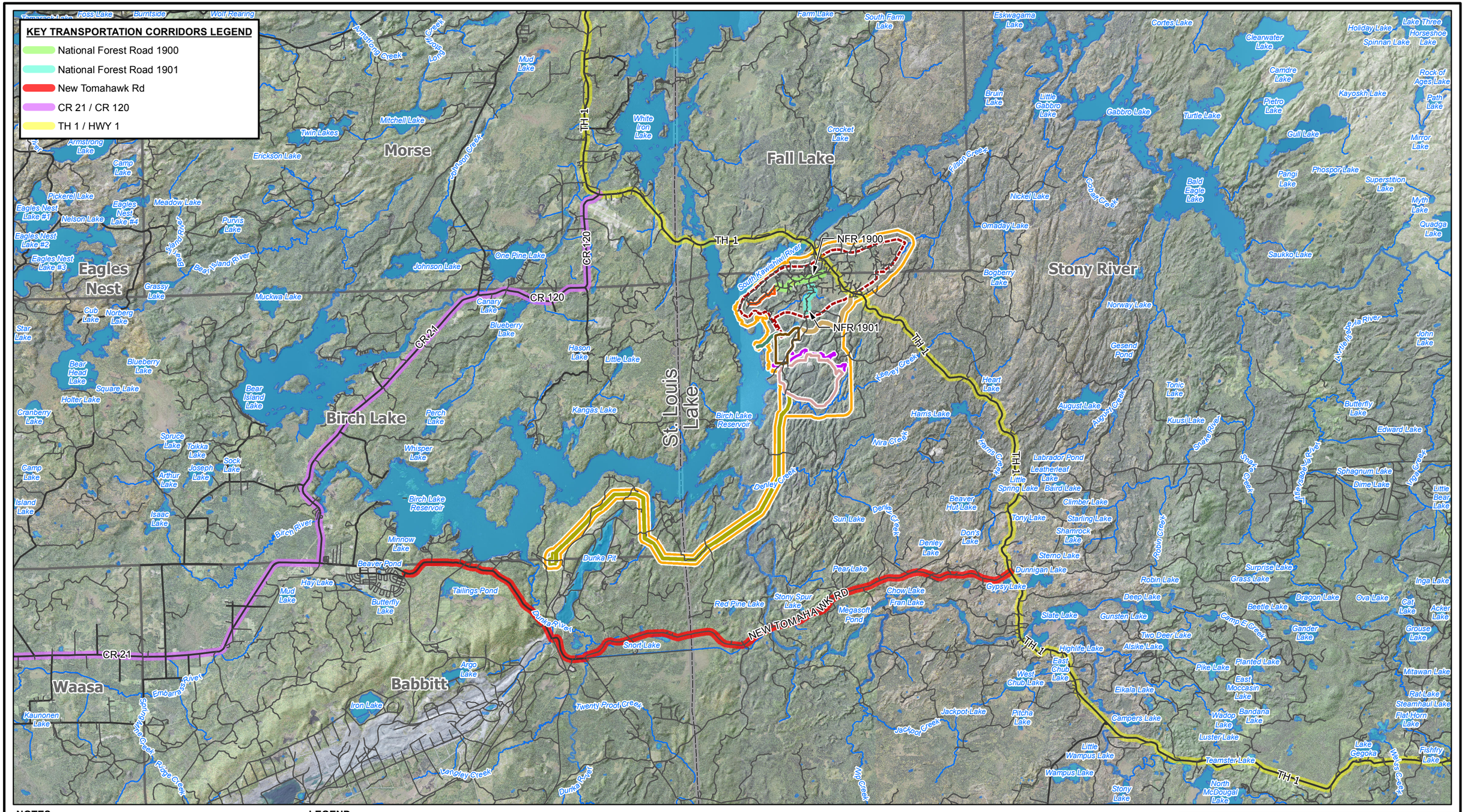
614 Table 7-1: Emergency Contact Information

Contact	Position/ Agency	Contact	Location	Phone Number(s)	Radio/Cell Phone Number
TMM Emergency Contacts	General Manager	To be determined	To be determined	To be determined	To be determined
TMM Emergency Contacts	Mine Superintendent	To be determined	To be determined	To be determined	To be determined
TMM Emergency Contacts	Process Superintendent	To be determined	To be determined	To be determined	To be determined
TMM Emergency Contacts	Maintenance Superintendent	To be determined	To be determined	To be determined	To be determined
TMM Emergency Contacts	Environmental Manager	To be determined	To be determined	To be determined	To be determined
TMM Emergency Contacts	Safety Officer	To be determined	To be determined	To be determined	To be determined
Off-site Emergency Contacts	Minnesota Interagency Coordination Center Operations	On Duty Personnel	402 Southeast 11th Street, Grand Rapids, Minnesota	218.327.4175	--
Off-site Emergency Contacts	BLM Northeastern States Office	On Duty Personnel	626 E. Wisconsin Ave., Suite 200 Milwaukee, WI 53202-4617	414.297.4400	--
Off-site Emergency Contacts	St. Louis County Sheriff's Office	On Duty Personnel	209 E Chapman St., Ely, MN 55731	218.726.2340	--
Off-site Emergency Contacts	Ely Fire Department	On Duty Personnel	209 East Chapman Street, Ely, Minnesota	218.365.3224	--
	Morse Fall Lake Fire Department	On Duty Personnel		218.365.7060	--

Contact	Position/ Agency	Contact	Location	Phone Number(s)	Radio/Cell Phone Number
Off-site Emergency Contacts			385 Kawishiwi Trail, Ely, Minnesota		
Off-site Emergency Contacts	Ely Area Ambulance Service	On Duty Personnel	328 West Conan Street, Ely, Minnesota	218.365.6322	--
Off-site Emergency Contacts	Ely Bloomenson Community Hospital	On Duty Personnel	328 West Conan Street, Ely, Minnesota	218.365.3271	--

615

FIGURES



NOTES:

1. Base air photo from the USDA Farm Service Agency, Aerial Photography Field Office.
2. Project related facilities and road data supplied by Twin Metals Minnesota
3. Hydrographic data from MDNR.
4. Horizontal datum based on NAD 1983. Horizontal coordinates based on Minnesota State Plane North (feet).

LEGEND

- Primary Road
- Secondary Road
- River/Stream
- Lake/Pond
- Plant Site
- Tailings Management Site
- Non-Contact Water Diversion Area
- Transmission Corridor
- Water Intake Corridor
- Ventilation Raises and Ventilation Raise Access Road
- Access Road Corridor
- Municipal Boundary
- County Boundary
- Project Area
- Underground Mine Area

TWIN METALS MINNESOTA

FIGURE 3-1

KEY TRANSPORTATION CORRIDORS

Scale: 0 1 2 Miles

Date: SEPTEMBER 2019

ATTACHMENT F.1

DISTRIBUTION TABLE

Number of Copies	Sent To

APPENDIX G

ENVIRONMENTAL QUALITY ASSURANCE PLAN

ENVIRONMENTAL QUALITY ASSURANCE PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
Prepared by SRK Consulting (U.S.), Inc.

Document No. TMM-ES-115-0003
Revision 0A
12-18-2019

REVISION RECORD

Revision	Date	Description	EDMS Download Date	Project Configuration Version
0A	12-18-2019	Issued for Agency Review	N/A	1.0

REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SUMMARY 1
3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT 2
3.1 INDICATORS OF DATA QUALITY 2
3.2 QUANTITATIVE DATA QUALITY OBJECTIVES 2
3.2.1 Precision 3
3.2.2 Accuracy 4
3.2.3 Completeness 4
3.3 QUALITATIVE DATA QUALITY OBJECTIVES 5
3.3.1 Representativeness 5
3.3.2 Comparability 5
4.0 SAMPLE CUSTODY 6
4.1 SAMPLE COLLECTION 6
4.2 LABORATORY SAMPLE 6
4.3 FINAL EVIDENCE FILES 6
5.0 CALIBRATION PROCEDURES 7
6.0 DATA REDUCTION AND VALIDATION 7
6.1 LABORATORY DATA REDUCTION AND REVIEW 8
6.2 DATA VALIDATION 8
7.0 INTERNAL QUALITY CONTROL 9
7.1 INSTRUMENT QC CHECKS 9
7.2 METHOD QC CHECKS 9
7.3 FIELD QC CHECKS 9
8.0 PREVENTIVE MAINTENANCE 9

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

COC	chain-of-custody
DQO	data quality objective
EDMS	Environmental Data Management System
etc.	abbreviation for the Latin phrase *et cetera* meaning "and other similar things" or "and so forth"
i.e.	Latin phrase id est meaning “That is (to say)…”
km	kilometers
Project	Twin Metals Minnesota Project
QA	quality assurance
QAP	Quality Assurance Plan
QC	quality control
RPD	relative percent difference
TMM	Twin Metals Minnesota LLC
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 kilometers) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process. TMM retained SRK Consulting (U.S.), Inc. to complete this environmental Quality Assurance Plan (QAP).

2.0 SUMMARY

This environmental QAP has been prepared for use in conducting environmental measurements related to Project operations and is intended to ensure that appropriate quality assurance (QA) and quality control (QC) measures are instituted and monitored during data collection activities and sample analyses. This environmental QAP also documents procedures to verify that deviations are appropriately corrected or justified. The use of a centrally managed QA program, as described herein, for environmental sampling and analysis activities ensures that precision, accuracy, representativeness, completeness, and comparability of data are known and documented in a consistent fashion.

If they occur, deviations from this environmental QAP would be documented in the field logbooks and/or Project files (paper and/or electronic) along with justification for changes in the procedure(s), as needed.

Sampling documentation, QA/QC measures, and associated data would ultimately be tracked through TMM's Environmental Data Management System (EDMS). The EDMS would ensure the storage, retrieval, tracking, and validation of environmental data throughout the Project's life.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT

The overall QA objective for monitoring data is to ensure that the data collected are sufficient and of adequate quality for their intended uses.

3.1 Indicators of Data Quality

Five parameters are used to evaluate the quality of data measurement:

- Precision;
- Accuracy;
- Representativeness;
- Completeness; and
- Comparability.

The precision and accuracy parameters provide a quantitative measure of the data quality based on evaluation of QC measurements. Completeness provides a method to compare the desired or planned number of results with the number of valid results. The remaining parameters, representativeness and comparability, use field documentation and laboratory procedures to qualitatively evaluate the success achieved in collecting appropriate data for the end uses.

QC samples from the field and laboratory would be used to monitor the precision and accuracy of the data gathered. These samples include blanks, duplicates, matrix spikes, laboratory control samples, etc. Relevant phases of sample collection, shipment preparation, and analysis are monitored through use of QC samples and checks.

Specific quantitative and qualitative objectives for each parameter or characteristic are established to develop sampling protocols and identify applicable documentation, sample handling procedures, and data acquisition procedures. Protocols presented herein are expected to be appropriate for several applications, but should be modified, as appropriate, to support the QA objectives established in each field sampling plan.

3.2 Quantitative Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the DQO planning process that clarify the purpose of the study, define the most appropriate type of information to collect, determine the most appropriate conditions from which to collect the information, and specify tolerable levels of potential decision errors. The DQO would be based on the data requirements of the decision maker who needs to feel confident that the data used to make environmental decisions are of adequate quality. Using the DQO process to plan environmental data collection

can help improve their effectiveness and efficiency and enhance the defensibility of decisions for which the data are used.

Quantitative DQOs typically encountered in environmental sampling programs include detection limits, precision, accuracy, and completeness.

By definition, a detection limit is the lowest amount of a substance that can be distinguished from the absence of that substance (the background) with a reasonable amount of certainty. Laboratories routinely refer to several different "detection limits" including the instrument detection limit, the method detection limit, and the practical quantitation limit. As such, it is imperative the Project work with the analytical laboratory to clearly define the quantitative detection limits for the various environmental media that will be monitored. Each environmental media to be monitored would need to be assessed on a case-by-case basis. In cases where concentrations are less than detection limits, a consistent approach would be used to estimate the concentration.

Precision, accuracy, and completeness QA objectives also need to be evaluated on a case-by-case, media-by-media basis in light of the intended end use of the data. The following sections describe these QA parameters in greater detail.

3.2.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Two types of precision are defined as having QA objectives:

- Laboratory precision; and
- Field sampling and analysis precision.

Laboratory and field precision are stated in terms of relative percent difference (RPD) according to the formula:

$$RPD = \frac{|(S - D)|}{(S + D) \times 0.5} \times 100$$

where, RPD = relative percent difference
S = sample result (first measured value)
D = duplicate sample result (second measured value)

Laboratory Precision

Analytical precision reflects the laboratory's ability to replicate a previously obtained value using identical testing procedures. Precision would be measured as the RPD between these replicate measurements.

The number of samples analyzed for laboratory precision would be in accordance with the method requirements.

Field Sampling and Analysis Precision

Field sampling and analysis precision, and the degree to which a given sample analysis represents the medium being sampled, would be assessed through the analysis of homogenized and/or co-located field duplicate samples submitted blind to the laboratory. The number of blind field duplicates submitted to the laboratory would be equal to 10 percent of the total number of samples submitted for a given monitoring quarter.

Note that field duplicates measure both field and laboratory precision. Results from field duplicates may have more variability than laboratory duplicates which only measure laboratory performance.

3.2.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. The accuracy is measured as the percent recovery of a given target analyte relative to its known concentration. The accuracy criterion, expressed as percent recovery, is evaluated by the formula:

$$\text{Accuracy} = \frac{(SS - S_1)}{SA} \times 100$$

where, SS = spiked sample result
S1 = sample result (first measured value, no spike)
SA = spike added (known or true value)

Accuracy would be evaluated through the laboratory QA/QC program.

3.2.3 Completeness

The characteristic of completeness is a quantitative measure of the amount of valid data obtained compared to the amount of valid data that was planned to accomplish the Project objectives. Completeness is evaluated according to the following formula:

$$\text{Percent Completeness} = \frac{TVM}{TM} \times 100$$

where, TVM = total number of valid measurements
TM = total number of measurements requested

The total number of measurements requested value is defined as the total number of analyses for which raw analytical results and corresponding QA/QC results are

requested. The total number of valid measurements value is defined as the number of these analytical results determined to be acceptable (including estimated values) through data validation and evaluation.

Typical analytical completeness objectives for environmental monitoring data are set at 90 percent. If data are rejected (i.e., not a valid measurement), a determination would be made of whether the rejected data are critical in meeting Project objectives. If data are considered critical, corrective action may be required.

3.3 Qualitative Data Quality Objectives

Qualitative DQOs are criteria used to assess the representativeness and comparability of site sample analyses. Qualitative DQO criteria include representativeness and comparability.

3.3.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness would be maintained during sampling efforts by sampling in accordance with a consistent procedure.

Consistent, uniform sample handling protocols, including such tasks as storage, preservation, and transportation, would be used to ensure that the representativeness of the samples gathered meet Project objectives. Proper documentation in the field and laboratory would verify that protocols have been followed and that sample identification as well as integrity have been preserved.

3.3.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability can be related to accuracy and precision as these quantities are measures of data reliability. Data are considered comparable if site conditions, collection techniques, and measurement procedures, methods, and reporting are of equivalent quality for the samples within a given sample set.

Comparability implies that the personnel involved in data acquisition and reduction operate measurement systems within the calibrated range of the particular instrument. In addition, analytical methodologies should produce comparable results. Analyses would be conducted using standard U.S. Environmental Protection Agency (USEPA) analytical methods or USEPA recommended methods, and samples would be collected following a consistent methodology in order to maximize the data comparability.

4.0 SAMPLE CUSTODY

Sample and document chain-of-custody (COC) procedures would be strictly adhered to during sample collection, transport, and laboratory handling to assure the identity and quality of samples. Proper COC procedures ensure the credibility and acceptability of analytical results. COC documentation should document the proper processing of samples from the time of collection to the time of analysis. A sample or an evidence file is under custody if, it is:

- In the actual possession or view of an individual;
- Locked or sealed to prevent tampering; or
- Stored in a secure area.

Custody is divided into three parts:

- Sample collection;
- Laboratory sample; and
- Final evidence files.

4.1 Sample Collection

COC records are employed to document custody transfers of samples during transportation or shipment to their intended destination. The possession and proper handling of samples must be traceable from the time the samples are collected until the analytical data have been accepted. The purpose of COC records is to handle all samples according to a properly documented and unbroken COC and to ensure such materials remain in their original state prior to testing.

4.2 Laboratory Sample

Analytical laboratories are responsible for tracking and documenting samples upon receipt of the samples at their facility. The laboratory sample custodian at each laboratory would ensure that the COC records are filled out upon receipt of the samples and would note questions or observations concerning sample integrity, including, but not limited to arrival temperatures, container conditions, and holding times.

4.3 Final Evidence Files

The final Project evidence file would be compiled by the Project Environmental Manager (or qualified representative designated by the Environmental Manager) and would contain the following information:

- Sample and QA/QC analytical data;

- Field laboratory data originals or copies (sample record forms, COC records, equipment calibrations, sample preparation log, etc.);
- Field logs;
- Field measurement data;
- Photographs;
- Calculations and notes; and/or
- Reports and drawings.

5.0 CALIBRATION PROCEDURES

Equipment used during field monitoring would require calibration to assure adherence to QA/QC objectives. Calibration would be performed for on-site equipment used for testing, inspections, and analytical purposes, as required by the manufacturer throughout the Project life. Equipment utilized in the field would be calibrated prior to use each day, unless otherwise specified by the manufacturer. The time and date of instrument calibration, along with other pertinent calibration information, would be documented in the field logbook or calibration log and signed. In some instances, specific pieces of equipment may require multiple calibrations during the day. These specific instances would be noted in the logs.

The instruments used in off-site testing of samples (i.e., laboratory chemical analyses) would be calibrated in accordance with the suggested protocol by the instrument manufacturer, and modified as required to reflect operational experience and, if appropriate, USEPA methodology.

6.0 DATA REDUCTION AND VALIDATION

The primary goal of the QA/QC program is to ensure that environmental-related measurements produce data of known quality and that data are of adequate quality for their intended uses. The quality of data is known when components associated with its derivation are thoroughly documented, with such documentation being verifiable and defensible.

The analytical data review process for analyses under this QAP would consist of two levels of review. The first level of review is performed by the analytical laboratory. The laboratory review program is designed to ensure that analytical data of known and acceptable quality have been provided by the laboratory. The second level of review is performed by TMM. TMM is responsible for conducting reviews of data packages received from the analytical laboratories to ensure compliance with the QA/QC provisions of this environmental QAP.

Data validation would be used to make an overall assessment of the data set and the usability of each analytical result.

6.1 Laboratory Data Reduction and Review

Data reduction is the process of converting measurement system outputs to an expression of the parameter consistent with the comparability objective. The exact equations used to calculate analyte concentrations are described within the analytical methods and procedures.

The first level of review, which may contain multiple sublevels, would be conducted by the analytical laboratory that has initial responsibility for the data correctness and completeness. The laboratory data reviewer would evaluate the quality of the analytical data based on an established set of laboratory guidelines.

The laboratory would perform the in-house analytical data reduction and QA review under the direction of the laboratory director or designee. The laboratory would be responsible for assessing data quality and advising TMM of data which were rated "preliminary" or "unacceptable," or other notations which would caution the data user of possible unreliability.

6.2 Data Validation

The second level of review and validation of the analytical data produced under this QAP would be performed by TMM (or a qualified third-party contractor specifically chosen for data validation). The purpose of this second level of review would be to provide an independent review of the data package, including a review of laboratory performance criteria and sample-specific criteria.

The second level of review would include a review of sample-specific criteria for data packages from each laboratory for each analysis type for parameters which are sample-related such as: holding times, surrogate recoveries, matrix spike recoveries, field duplicates, matrix spike duplicates, laboratory duplicate precision, post digestion (analytical) spike recoveries, inductively coupled plasma serial dilution analysis agreement, and qualification of sample data based on analytes reported as detected in blank analyses.

Variances identified during the second-level review would be reported to the laboratory. Repeated variances of the laboratory performance criteria, which may indicate a systematic problem, would result in immediate corrective action, which may include, but is not limited to the removal of the laboratory from the Project analytical program.

7.0 INTERNAL QUALITY CONTROL

QC procedures are established for laboratory and field activities. The elements of QC fall into three groups:

- Instrument QC;
- Method QC; and
- Field QC.

7.1 Instrument QC Checks

Instrument QC checks ensure that an instrument is calibrated and functioning properly. The frequency and nature of laboratory instrument QC checks are presented in laboratory QAPs. Field instrumentation would be calibrated and utilized in accordance with the manufacturer's instructions.

7.2 Method QC Checks

Method QC checks monitor the precision and accuracy of both sample preparation and analysis. Method QC checks may, in addition, provide information on intra-laboratory reproducibility of a method and of matrix effects. Laboratory QC objectives would be met as specified in method requirements.

7.3 Field QC Checks

Field QC checks monitor sampling by itself and the overall process of sampling, sample preparation, and analysis. Field QC is a qualitative process dependent on the decisions made by personnel while performing individual tasks. Specific field QC procedures include completion of appropriate sampling procedures, including, but not limited to:

- Field document control;
- Decontamination of sampling equipment; and
- Sample custody and shipping procedures.

The review criteria for field QC checks, and results for the above listed samples, would be utilized for providing a professional opinion on the data quality and usability.

8.0 PREVENTIVE MAINTENANCE

Preventive maintenance tasks would be carried out on both field and laboratory equipment to minimize downtime. Preventive maintenance of field equipment would proceed routinely before each sampling event. Additional maintenance would be performed on the basis of hours in use. Laboratory equipment would be maintained

on a regular and scheduled basis. Site visits to third-party laboratories to ensure compliance with preventative maintenance requirements would be executed as necessary.

APPENDIX H

INTERIM MANAGEMENT PLAN

INTERIM MANAGEMENT PLAN

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota LLC
Prepared by
SRK Consulting (U.S.), Inc.

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REVISION RECORD

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REVISION NARRATIVE

Not Applicable

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 SUMMARY 1
3.0 SCHEDULE OF ANTICIPATED PERIODS OF TEMPORARY CLOSURE 1
4.0 MEASURES TO STABILIZE EXCAVATIONS AND WORKINGS 3
5.0 MEASURES TO ISOLATE OR CONTROL TOXIC OR DELETERIOUS MATERIALS 3
5.1 REAGENTS 3
5.2 PROCESS COMPONENTS 4
5.2.1 Concentrator 4
5.2.2 Tailings Thickener and Filter Plant 4
5.2.3 Backfill Plant 4
5.3 DRY STACK FACILITY 4
5.4 WATER INTAKE PIPELINE AND WATER INTAKE FACILITY 4
5.5 NON-CONTACT WATER MANAGEMENT PLAN 5
5.6 CONTACT WATER MANAGEMENT 5
6.0 STORAGE OR REMOVAL OF EQUIPMENT, SUPPLIES, AND STRUCTURES 5
7.0 MEASURES TO MAINTAIN THE PROJECT AREA IN A SAFE AND CLEAN CONDITION 6
8.0 MONITORING DURING PERIODS OF NON-OPERATION 6

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

§	section
i.e.	Latin phrase id est meaning “That is (to say)…”
MDNR	Minnesota Department of Natural Resources
Minn R.	Minnesota Administrative Rules
MPO	Mine Plan of Operations
Project	Twin Metals Minnesota Project
TMM	Twin Metals Minnesota LLC

1.0 INTRODUCTION

The Twin Metals Minnesota LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of the city of Ely, Minnesota, and 11 miles (18 km) northeast of the city of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at: http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process. TMM retained SRK Consulting (U.S.), Inc. to complete this Interim Management Plan.

2.0 SUMMARY

The following Interim Management Plan has been prepared as part of the Project's Mine Plan of Operations (MPO) to inform Project management during periods of unplanned temporary closure to prevent unnecessary and undue degradation to the environment. This Interim Management Plan is necessarily general to cover scenarios of unplanned temporary closure. For the purposes of this Interim Management Plan, unplanned temporary closure is defined as the closure of Project mining and / or processing facilities exceeding 30 calendar days. The contents of this Interim Management Plan include:

- A schedule of anticipated periods of temporary closure during which the Interim Management Plan would be implemented, including provisions for notifying the designated agency of unplanned or extended temporary closures;
- Measures to stabilize excavations and workings;
- Measures to isolate and control toxic or deleterious materials;
- Provisions for the storage or removal of equipment, supplies, and structures;
- Measures to maintain the Project area in a safe and clean condition; and
- Plans for monitoring site conditions during periods of non-operation.

3.0 SCHEDULE OF ANTICIPATED PERIODS OF TEMPORARY CLOSURE

The standard operating schedule for the Project will be 24 hours a day, 365 days a year for mining and processing activities. No unplanned temporary closures or interim closures are currently anticipated. However, it is possible that, due to

mechanical or technical difficulties, unfavorable economic conditions, or other unforeseen events, mining and/or processing facilities may have to be temporarily closed.

In the event of an unplanned temporary closure, the following notification procedures, as per Minnesota Administrative Rules (Minn. R.) section (§) 6132.3200, would be implemented:

- Pursuant to Minn. R. § 6132.3200 Subp. 2 (A) the commissioner (i.e. the commissioner of natural resources or the commissioner's designated representative) would be notified immediately when the permittee is aware of a temporary shutdown.
- Pursuant to Minn. R. § 6132.3200 Subp. 2 (B), notification for a temporary shutdown would include:
    - The reason for temporary shutdown;
    - A projection of when the temporary shutdown will end;
    - A maintenance plan for the temporary shutdown period to ensure that the facilities will remain stable and hazard free;
    - Documentation of how permit standards will be complied with during the shutdown;
    - Maintenance of full financial assurance;
    - Completion of corrective action requirements as scheduled; and
    - Compliance with reporting requirements.
- Pursuant to Minn. R. § 6132.3200 Subp. 2 (C), the commissioner, after review of the requirements, may either:
    - Approve the temporary shutdown;
    - Request more information to make a decision; or
    - Deny the temporary shutdown and direct the permittee to implement a contingency reclamation plan, as stipulated under Minn. R. § 6132.1300.
- Pursuant to Minn. R. § 6132.3200 Subp. 2 (D), in evaluating a request for an extension of a temporary shutdown, the commissioner shall:
    - Evaluate compliance with state and federal permits;
    - Evaluate safety and stability of mining facilities; and
    - Evaluate the need to implement corrective action procedures.

In the event of an unplanned temporary closure, TMM would also:

- Supply the lead agency and the Minnesota Department of Natural Resources (MDNR) with a list of supervisory personnel who would oversee the Project during the unplanned temporary closure period. This list would include the number of support staff required in each department to maintain the facility during the unplanned temporary closure period. Standard security procedures would remain in place for the duration of the unplanned temporary closure period. Access to the site would be allowed for appropriate regulatory agency personnel;

- In the event of an unplanned temporary closure in winter months, the lead agency and the MDNR would be notified when the unplanned temporary closure of Project mining and/or processing facilities exceeds 30 calendar days. The notification would include a description of the procedures and controls that have been or will be carried out to maintain process components during the winter closure period; and
- Following a period of unplanned temporary closure period in the winter months, but prior to startup, elements of the underground mine, plant site, tailings management site, water intake corridor, and associated process water, contact water, and stormwater management systems would be inspected for signs of damage or deterioration.

TMM would evaluate procedures to carry out permanent closure of the Project if and when restart is not feasible.

4.0 MEASURES TO STABILIZE EXCAVATIONS AND WORKINGS

Depending on the length of the unplanned temporary closure, dewatering of the underground mine may be discontinued or continued. If the underground mine would continue to be dewatered during periods of unplanned temporary closure, dewatering water would continue to be sent to the sediment pond, where it would overflow into the process water pond. No additional measures would be necessary to stabilize the underground excavations and workings. Interim reclamation procedures would be implemented, as necessary, to stabilize disturbed sites during the unplanned temporary closure period. These procedures would be coordinated with the lead agency and the MDNR.

5.0 MEASURES TO ISOLATE OR CONTROL TOXIC OR DELETERIOUS MATERIALS

5.1 Reagents

The extent of reagent management would be dependent upon the anticipated length of the unplanned temporary closure. If reasonable, unused reagents would be returned to vendors in the event of an extended period of closure. Partially used process reagents would be stabilized by sealing the containers and ensuring they are stored in an appropriate location where secondary containment is provided. Explosives would continue to be stored and handled according to federal and state regulations. Hazardous materials would continue to be stored, handled, and disposed of according to federal and state regulations and in accordance with applicable Project permits.

5.2 Process Components

Under temporary closure, remaining ore materials would be processed and cleared from the following facilities to ensure that plumbing would not be subjected to freezing during extended cold periods. This action would also prepare the process facilities for the resumption of operations at the end of temporary closure.

5.2.1 Concentrator

Cleared materials from the concentrator (the comminution and flotation circuits, concentrate dewatering, and the storage and loadout circuit) would generally report to the tailings thickener and filter plant. Excess cleared liquids would report to the process water pond. Excess cleared solids from the semi-autogenous mill and ball mill would be transported back to the coarse ore stockpile.

5.2.2 Tailings Thickener and Filter Plant

Cleared solids (tailings) from the tailings thickener and filter plant would report to the filter cake storage and loadout building prior to placement on the dry stack facility and excess cleared liquids would report to the process water pond.

5.2.3 Backfill Plant

Excess tailings remaining in the backfill plant would be blended with a binder for use as engineered tailings backfill. All remaining engineered tailings backfill from the backfill plant would report to the underground mine as backfill, and excess water would report to the process water pond.

5.3 Dry Stack Facility

During unplanned temporary closure, the dry stack facility would be graded to minimize concentrated flow, limit flow velocities, and reduce erosion potential. Progressive reclamation of the dry stack facility would be maximized to the extent practicable to accelerate revegetation of disturbed areas.

5.4 Water Intake Pipeline and Water Intake Facility

During unplanned temporary closure, remaining water in the water intake pipeline and water intake facility would be drained back into Birch Lake reservoir to prevent damage from freezing.

5.5 Non-Contact Water Management Plan

During periods of unplanned temporary closure, non-contact water would continue to be managed in accordance with the Project's Non-contact Water Management Plan, included as Appendix C to the MPO.

5.6 Contact Water Management

During periods of unplanned temporary closure, contact water would continue to be managed in accordance with the Project's Contact and Process Water Management Plan, included as Appendix D to the MPO. Additional details regarding the management of contact water during periods of unplanned temporary closure will be provided in future versions of this Interim Management Plan.

6.0 STORAGE OR REMOVAL OF EQUIPMENT, SUPPLIES, AND STRUCTURES

In the event of an unplanned temporary closure, it is anticipated that equipment, supplies, and structures would not be removed or placed into storage. Some mobile equipment or bulk commodities may be relocated into buildings or covered with tarps to isolate them from the weather, depending on the anticipated duration of the unplanned temporary closure. In addition, the following steps would be undertaken:

- Additional reagents would not be introduced into process components during the unplanned temporary closure period;
- Stored equipment would be clearly identified as having contained process solutions;
- Mine equipment remaining in operation during the unplanned temporary closure, including haul trucks, shovels, loaders, drills, and personal vehicles would continue to be maintained according to standard company procedures and manufacturer's recommendations; and
- Following the unplanned temporary closure period, the integrity of the entire fluid management system would be evaluated before start-up is initiated. Solution tanks, pumps, and piping would be visually inspected and repaired as necessary. The processing circuit would be charged with process solution and reagents and visually inspected for evidence of leaks. Mine equipment would be inspected for compliance with appropriate federal and state mining regulations before mining activities resume. The mine dewatering system would be visually inspected and repaired, as necessary.

7.0 MEASURES TO MAINTAIN THE PROJECT AREA IN A SAFE AND CLEAN CONDITION

Safety provisions would remain in place during an unplanned temporary closure period and would include public access restrictions, applicable personnel safety equipment, and safety protocol.

8.0 MONITORING DURING PERIODS OF NON-OPERATION

Provisions of applicable permits, this Interim Management Plan, and other regulatory requirements would continue to be met during the unplanned temporary closure period. This would include monitoring, notifications, and report submittals. Site monitoring and monitoring of leak detection systems for vessels and piping containing process solution would continue throughout the unplanned temporary closure period.